5- 4320-307-24

TM 5-4320-307-24

TECHNICAL MANUAL

UNIT
DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL

INTRODUCTION 1-1

UNIT MAINTENANCE INSTRUCTIONS 2-1

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS 3-1

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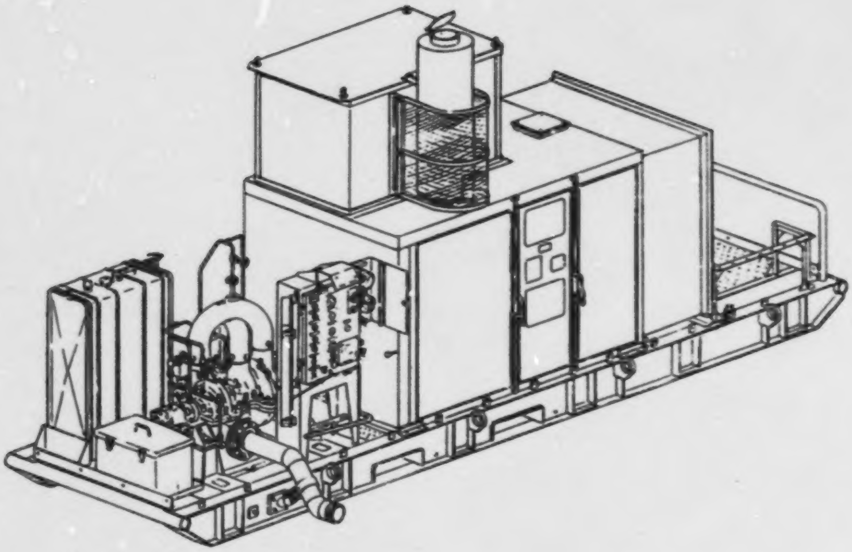

PUMPING ASSEMBLY (MAINLINE)
DIESEL ENGINE DRIVEN, 800 GPM
NSN 4320-01-193-3430

Approved for public release; distribution is unlimited

HEADQUARTERS DEPARTMENT OF THE ARMY
14 AUGUST 1989

READEX FICHE best copy available

D101.11:

WARNING

DEATH OR SERIOUS INJURY

could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

DEATH OR SERIOUS INJURY

to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress of hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

SERIOUS INJURY

could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

DEATH OR SERIOUS INJURY

Leave filler caps installed while battery is being charged. Charge battery in a well-ventilated area. Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.

DEATH OR SERIOUS INJURY

could occur if diesel fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Engine must be turned off and cool before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engine near open fuel containers. Always store fuel in proper, marked containers. DO NOT SMOKE.

WARNING

SERIOUS INJURY

Be sure engine is shut down and control panel is closed to prevent accidental starting while doors are open. If necessary to run engine with open doors, be sure that area around V-belts is clear of personnel and tooling.

SERIOUS INJURY

Do not remove the air inlet and exhaust elbows while the engine is running.

SERIOUS INJURY

Objects entering the turbine and compressor chambers could seriously damage the turbocharger, and fragments ejected from the chambers could cause serious eye injuries.

SEVERE BURNS

can be caused by turbocharger and exhaust system heated during operation of the engine. If the engine has been running, do not touch the turbocharger or exhaust system components until they have cooled.

SERIOUS INJURY

Do not allow battery box top to come in contact with electrical connections.

DEATH OR SERIOUS INJURY

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

SERIOUS INJURY

Connect positive battery cables to battery first to prevent shocks and damage to other electrical system components.

WARNING

HEALTH AND SAFETY HAZARD

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

DEATH AND SERIOUS INJURY

could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

EXPLOSION HAZARD

Ether is highly flammable. Do not use near sparks or open flame. Do not inhale fumes. Do not operate ether valve for more than three seconds. Overloading the engine air housing with this highly flammable fluid (ether) could result in an explosion.

SEVERE INJURY

may result from contact with rotating engine part, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting. If it is necessary to run engine with rotating parts exposed, be sure the area around the moving parts is clear of personnel and tools.

SEVERE BURNS

Handling hot exhaust system can cause severe burns. Allow unit to cool before handling.

WARNING

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

HEALTH AND SAFETY HAZARD

Operate acetylene torches properly and be alert for leaks on any part of the equipment. Inhalation of acetylene produces headache, dizziness, nausea, and possible loss of consciousness. If acetylene is inhaled, seek fresh air immediately.

EXPLOSION HAZARD

Before application of heat, such as open flame, torch, or arc welding, be sure that all traces of cleaning solvent or flammable fluids or vapors are absent from the repair area.

TECHNICAL MANUAL

NO 5-4320-307-24

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C. 14 August 1989

Unit, Direct Support and General Support Maintenance Manual

PUMPING ASSEMBLY (MAINLINE)
DIESEL ENGINE DRIVEN, 800 GPM
NSN 4320-01-193-3430

Approved for public release; distribution is unlimited

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes, or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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CHAPTER 1
INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

Type of Manual: Unit, Direct Support, and General Support Maintenance

Model Number and Equipment Name: Pumping Assembly, Mainline, 800 GPM, Diesel Engine Driven, Part Number 0053009500

Purpose of Equipment: Pumps petroleum based fuels or water with specific gravities between 0.72 and 1.0

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System (TAMMS).

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE

Refer to TM 750-244-3 for instructions.

1-4. PREPARATION FOR STORAGE AND SHIPMENT

Instructions for preparation for storage and shipment are in Chapter 2.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S)

If your pumping assembly needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at: U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We will send you a reply.

1-6. NOMENCLATURE CROSS-REFERENCE

For precise identification, simplified nomenclature has been established for clarity and is shown in the nomenclature cross-reference list.

NOMENCLATURE CROSS-REFERENCE LIST

This listing includes nomenclature cross-references used in this manual.

Common Name	Official Nomenclature
Pumping Assembly	Pumping Assembly, Mainline, Diesel Engine Driven, 800 GPM
Engine	Engine Assembly, Dual Turbocharged Diesel, NTTA-855-P450
Pump	Pump Assembly, PN 0053000100
Power Takeoff	Speed Increaser w/Clutch, PN 0053020200
Gear Box	Speed Increaser w/Clutch, PN 0053020200

1-7. WARRANTY INFORMATION

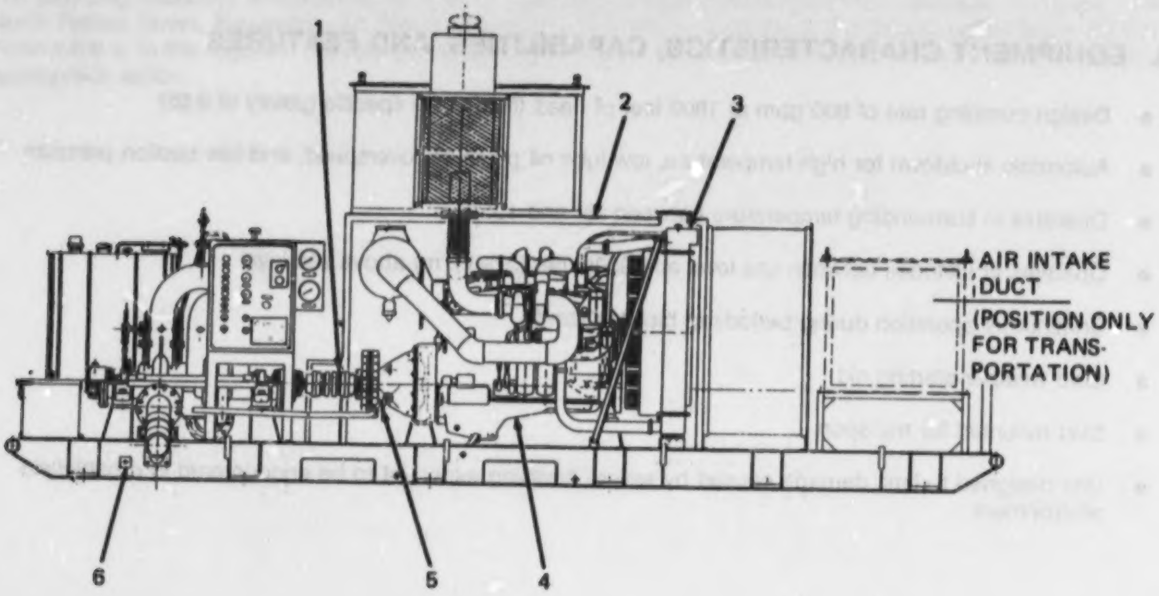
The pumping assembly is warranted by S. P. A. Termomeccanica Italiana, C/O The Crenshaw Company, 1199 North Fairfax Street, Alexandria, VA 22314 for a period of 2 years. It starts on the date found in block 23, DA Form 2408-9, in the logbook. Report all defects in material or workmanship to your supervisor who will take appropriate action.

Section II. EQUIPMENT DESCRIPTION AND DATA

1-8. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

- Design pumping rate of 800 gpm at 1800 feet of head (fluids with specific gravity of 0.85)
- Automatic shutdown for high temperature, low lube oil pressure, overspeed, and low suction pressure
- Operates in surrounding temperature between 25° and 135°F
- Operates at altitudes between sea level and 9000 feet (2743.2 m) above sea level
- Continuous operation during periods of blowing sand
- Cold weather starting aid
- Skid mounted for transport
- Unit designed to limit damage caused by severe handling expected to be encountered in a battlefield environment

1-9. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS



RIGHT SIDE VIEW

FLEXIBLE COUPLING (1). The flexible coupling is used to connect the speed increaser to the pump.

ENGINE ENCLOSURE (2). The enclosure boxes the engine along its sides, top, and ends. Four hinged doors and two removable side panels provide accessibility to the engine. The air intake duct on top and the muffler are removable for transportation.

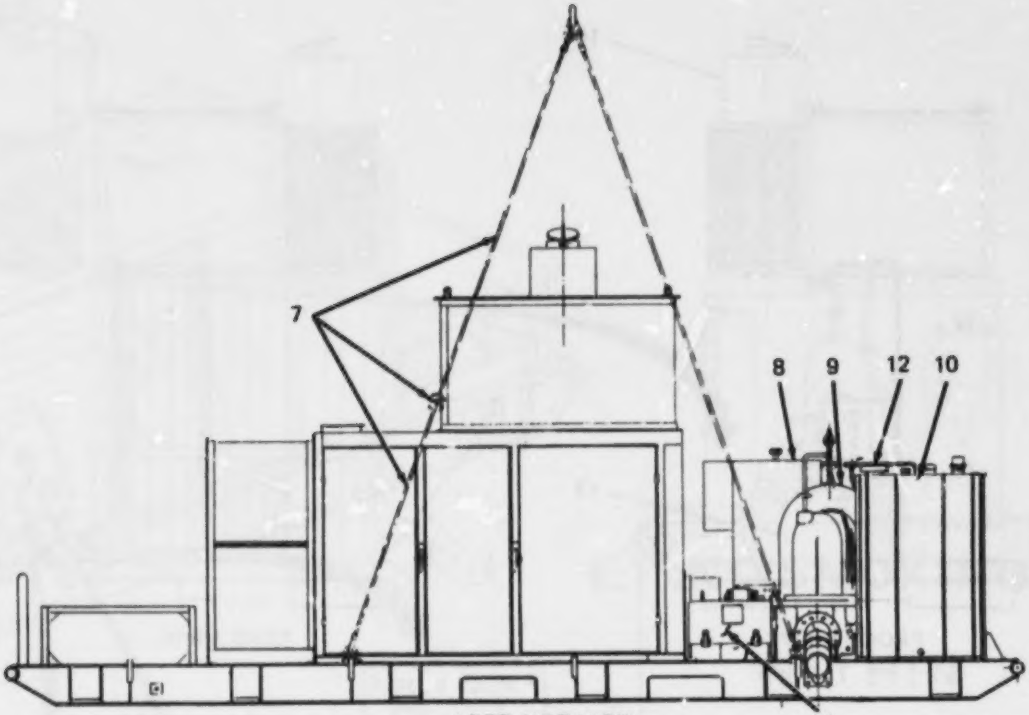
COOLANT RADIATOR (3). The radiator is part of the engine cooling system that maintains the engine coolant at specified temperature during operation.

ENGINE ASSEMBLY (4). The engine is a dual turbocharged diesel engine capable of providing 450 hp at 2100 rpm while in continuous operation.

SPEED INCREASER (5). The speed increaser is used to increase engine speed to optimum pump speed of 3458 rpm. A clutch lever extends from the speed increaser gear box to a position in front of the control panel.

GROUNDING ROD CONNECTION POINT (6). The grounding rod connection point provides a connection point for the grounding rod cable assemblies.

1-9. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS (CONT)



LEFT SIDE VIEW

LIFTING BAIL ASSEMBLY (7). A lifting bail assembly is provided to lift the pumping assembly into position. The lifting bail assembly is connected to four locations on the skid when in use; otherwise, stored on the skid. Spreader bars are attached between lifting bail assembly to prevent damage to pumping assembly when lifting.

CONTROL PANEL (8). The control panel encloses the pumping assembly controls and indicators, which include a tachometer/hourmeter, lube oil pressure gauge, coolant water temperature gauge, suction pressure gauge, discharge pressure gauge, on/off switches, malfunction lights, test switch, start/stop switch, auto/manual switch, and engine speed/pump discharge pressure potentiometer. A work light is mounted to the top of the control panel. The light switch and dimmer control are also mounted on the panel face.

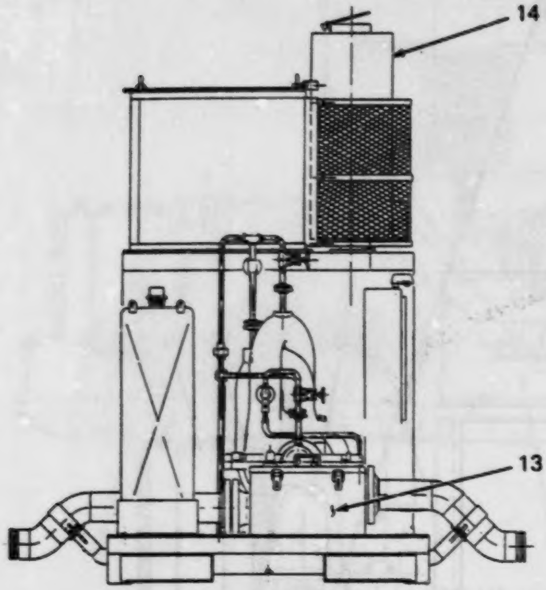
PUMP (9). The installed pump is a three-stage centrifugal pump with a design capacity of 800 gpm.

FUEL TANK (10). The fuel tank is mounted to the skid. The fuel tank has a capacity of 110 gallons and is designed to provide 4 hours of operation at maximum continuous power without refueling. The fuel level in the tank is indicated by a mechanical liquid level gauge graduated from empty to full.

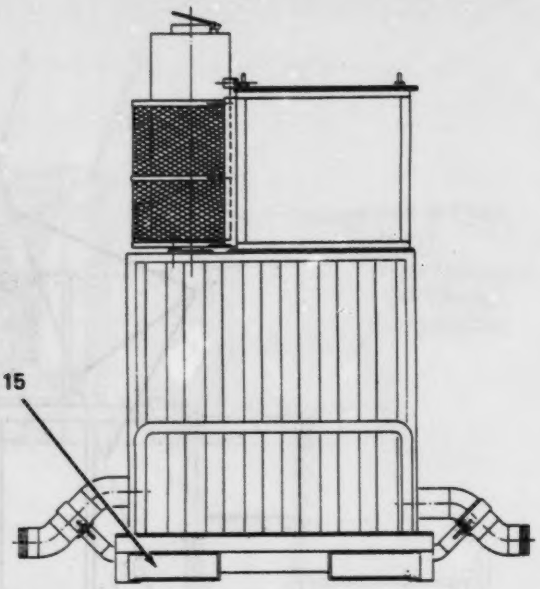
BATTERY BOX (11). The battery box contains four lead acid 12-bolt batteries, two in series and two in parallel.

FUEL FEEDING SYSTEM (12). The fuel feeding system consists of a precleaner, hand pump, fuel feed pump, injection pump, injectors, and dual fuel filters. The primary filter is a water separating type. Two 3-way valves with corrosion resistant tags marked OFF, UNIT TANK, and AUXILIARY are connected in line to a 110-gallon fuel tank.

1-9. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS (CONT)



FRONT VIEW



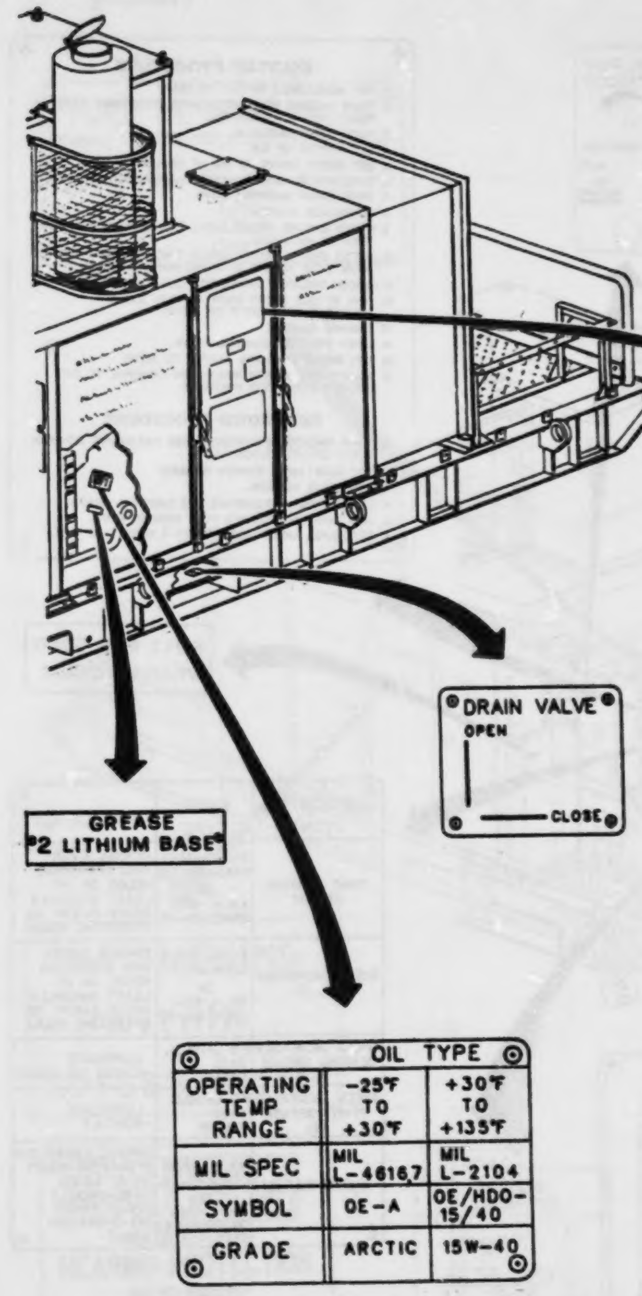
REAR VIEW

STORAGE BOX (13). A storage box is mounted to the rear of the skid. Items stored in the box are: technical manuals, cotton duck bag, air cleaner rain cap, auxiliary fuel hoses, flange gaskets, nozzle mounting bolts, shims for engine, allen wrench, ground cables, and enclosure lifting eyes.

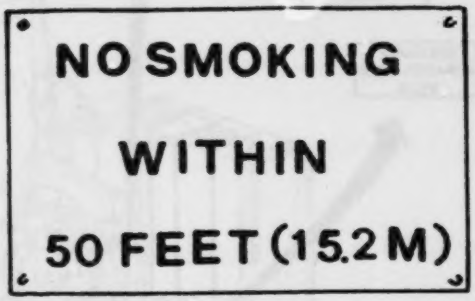
ENGINE EXHAUST SYSTEM (14). The engine is equipped with a spark arresting exhaust muffler. The muffler is fitted with a guard and is installed in the vertical position. The muffler may be easily removed and stored on the front end of the skid during transportation of the pumping assembly.

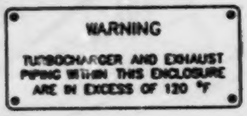
SKID ASSEMBLY (15). The skid measures approximately 23 by 6 1/2 feet. The ends of the skid are beveled upward and forklift pockets are in its base (front and back) to allow four-way entry by forklift. The size of the forklift entry pockets are 6 by 20 inches. Side pockets penetrate the width of the skid. End pockets penetrate 75 inches. The skid runners are furnished with 12 mounting holes for anchoring the assembly to a foundation. The skid has four tiedown devices and four multipurpose devices (tiedown and lifting). A grounding system allows all noncurrent metallic parts of the pumping assembly to be connected to two grounding pads at the opposite corners of the skid. Items stored on the skid during storage and transportation are: muffler, muffler guard, grounding rods, air intake duct, lifting bail assembly, nozzle adapters, coupling, and battery electrolyte.

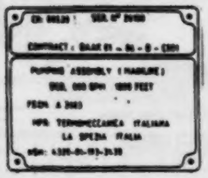
1-10. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES

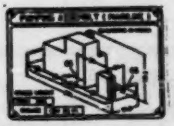

DRAIN VALVE
OPEN
CLOSE
GREASE
#2 LITHIUM BASE#
OIL TYPE

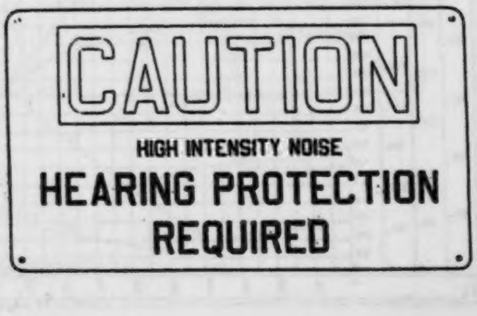
OIL TYPE		
OPERATING TEMP RANGE	-25°F TO +30°F	+30°F TO +135°F
MIL SPEC	MIL L-46167	MIL L-2104
SYMBOL	OE-A	OE/HDO-15/40
GRADE	ARCTIC	15W-40


NO SMOKING
WITHIN
50 FEET (15.2 M)

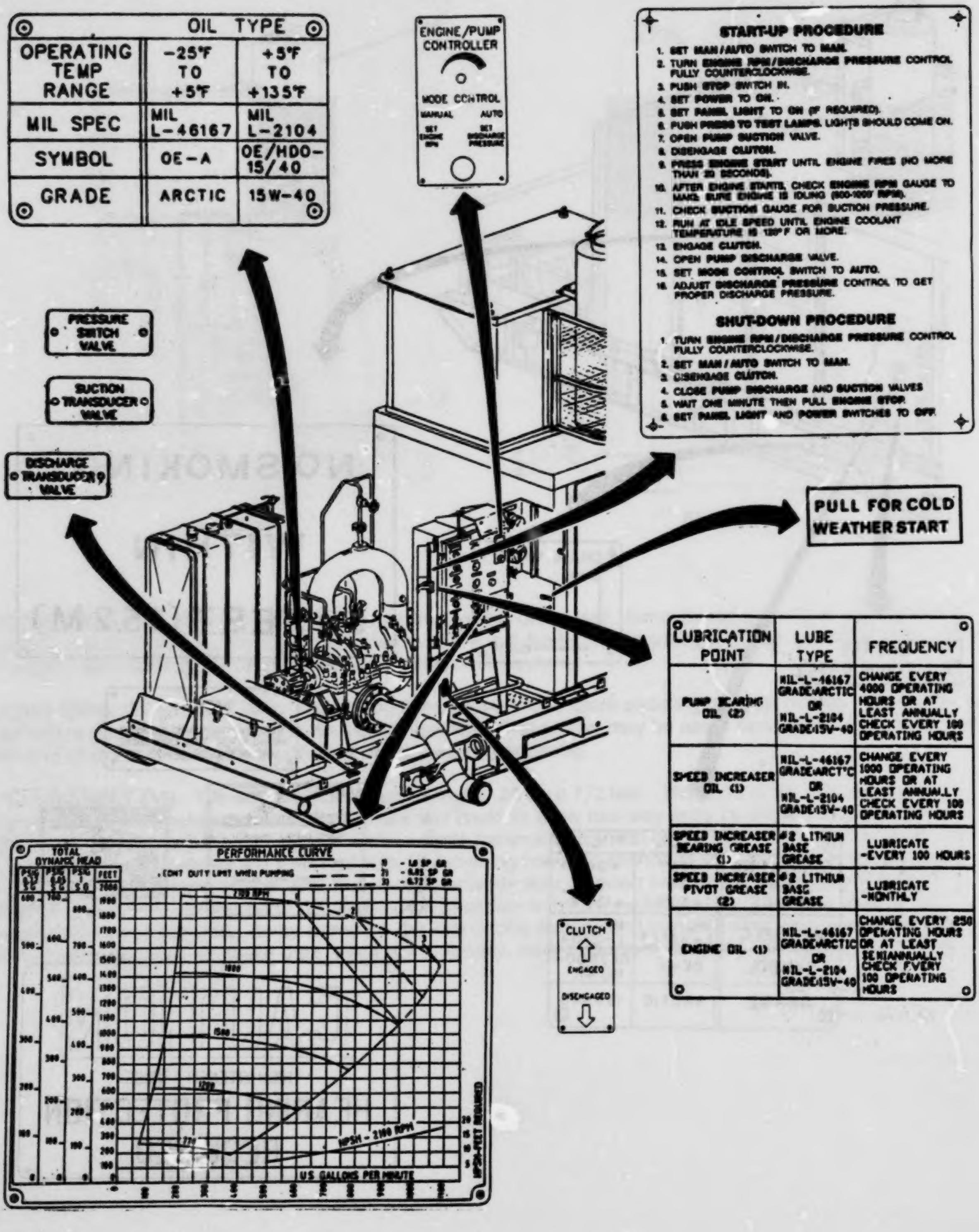

WARNING
TURBOCHARGER AND EXHAUST PIPING WITHIN THIS ENCLOSURE ARE IN EXCESS OF 120 °F


CONTRACT
PUMPING ASSEMBLY (MARINE)
MFR: TERMOMECCANICA ITALIANA
LA SPEZIA ITALIA




CAUTION
HIGH INTENSITY NOISE
HEARING PROTECTION REQUIRED

1-10. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES (CONT)



OIL TYPE		
OPERATING TEMP RANGE	-25°F TO +5°F	+5°F TO +135°F
MIL SPEC	MIL L-46167	MIL L-2104
SYMBOL	OE-A	OE/HDO-15/40
GRADE	ARCTIC	15W-40

ENGINE/PUMP CONTROLLER
MODE CONTROL
MANUAL
AUTO
SET ENGINE RPM
SET DISCHARGE PRESSURE
PRESSURE SWITCH VALVE
SUCTION TRANSDUCER VALVE
DISCHARGE TRANSDUCER VALVE
PULL FOR COLD WEATHER START
CLUTCH
ENGAGED
DISENGAGED

START-UP PROCEDURE

1. SET MAN/AUTO SWITCH TO MAN.
2. TURN ENGINE RPM/DISCHARGE PRESSURE CONTROL FULLY COUNTERCLOCKWISE.
3. PUSH STOP SWITCH IN.
4. SET POWER TO ON.
5. SET PANEL LIGHT TO ON (IF REQUIRED).
6. PUSH PRESS TO TEST LAMPS. LIGHTS SHOULD COME ON.
7. OPEN PUMP SUCTION VALVE.
8. DISENGAGE CLUTCH.
9. PRESS ENGINE START UNTIL ENGINE FIRES (NO MORE THAN 20 SECONDS).
10. AFTER ENGINE STARTS, CHECK ENGINE RPM GAUGE TO MAKE SURE ENGINE IS IDLING (800-1000 RPM).
11. CHECK SUCTION GAUGE FOR SUCTION PRESSURE.
12. RUN AT IDLE SPEED UNTIL ENGINE COOLANT TEMPERATURE IS 120°F OR MORE.
13. ENGAGE CLUTCH.
14. OPEN PUMP DISCHARGE VALVE.
15. SET MODE CONTROL SWITCH TO AUTO.
16. ADJUST DISCHARGE PRESSURE CONTROL TO GET PROPER DISCHARGE PRESSURE.

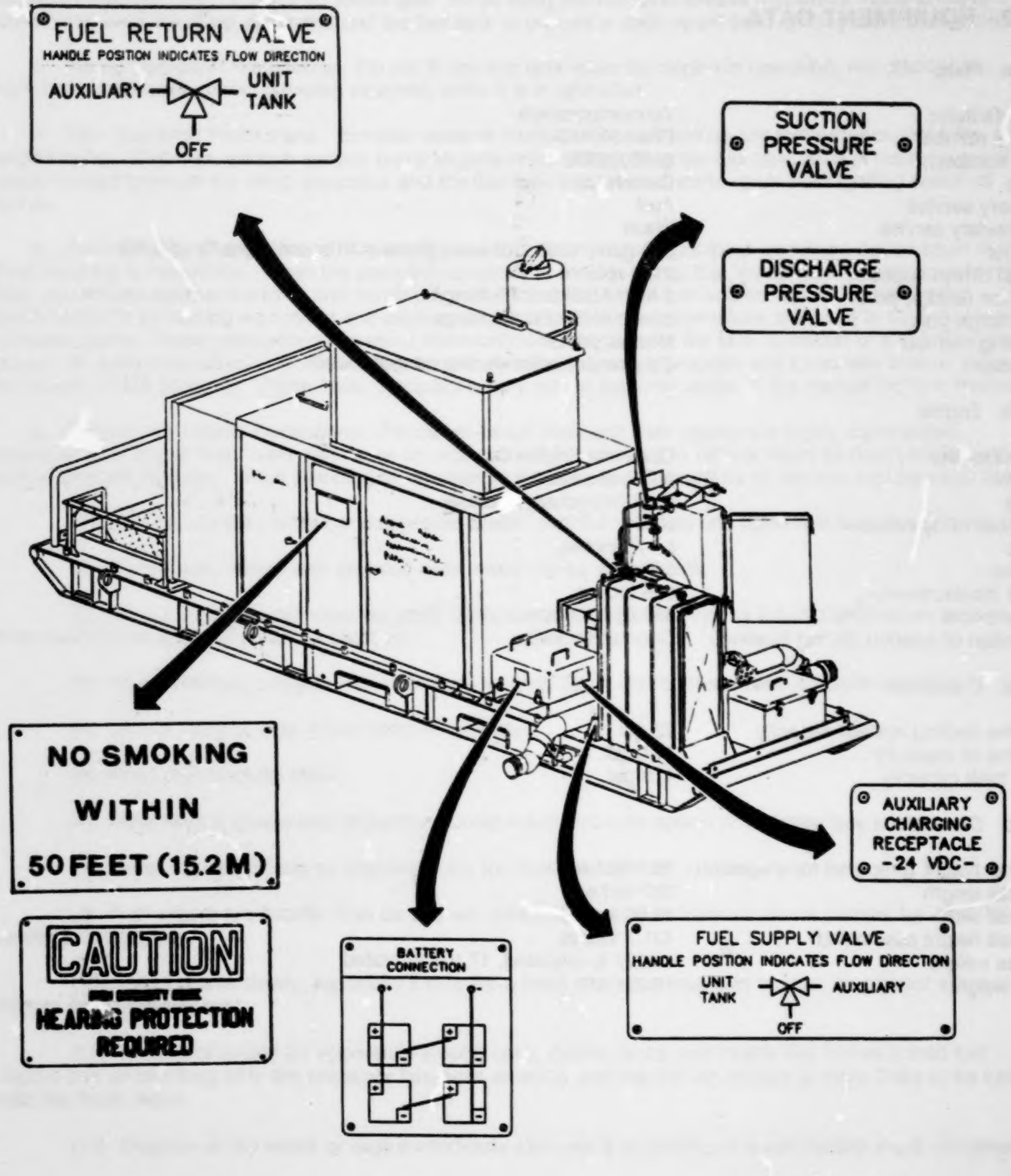
SHUT-DOWN PROCEDURE

1. TURN ENGINE RPM/DISCHARGE PRESSURE CONTROL FULLY COUNTERCLOCKWISE.
2. SET MAN/AUTO SWITCH TO MAN.
3. DISENGAGE CLUTCH.
4. CLOSE PUMP DISCHARGE AND SUCTION VALVES
5. WAIT ONE MINUTE THEN PULL ENGINE STOP.
6. SET PANEL LIGHT AND POWER SWITCHES TO OFF.

LUBRICATION POINT	LUBE TYPE	FREQUENCY
PUMP BEARING OIL (2)	MIL-L-46167 GRADE:ARCTIC OR MIL-L-2104 GRADE:15W-40	CHANGE EVERY 4000 OPERATING HOURS OR AT LEAST ANNUALLY CHECK EVERY 100 OPERATING HOURS
SPEED INCREASER OIL (1)	MIL-L-46167 GRADE:ARCTIC OR MIL-L-2104 GRADE:15W-40	CHANGE EVERY 1000 OPERATING HOURS OR AT LEAST ANNUALLY CHECK EVERY 100 OPERATING HOURS
SPEED INCREASER BEARING GREASE (1)	#2 LITHIUM BASE GREASE	LUBRICATE -EVERY 100 HOURS
SPEED INCREASER PIVOT GREASE (2)	#2 LITHIUM BASE GREASE	LUBRICATE -MONTHLY
ENGINE OIL (1)	MIL-L-46167 GRADE:ARCTIC OR MIL-L-2104 GRADE:15W-40	CHANGE EVERY 250 OPERATING HOURS OR AT LEAST SEMIANNUALLY CHECK EVERY 100 OPERATING HOURS

PERFORMANCE CURVE
TOTAL DYNAMIC HEAD
PSIG
PSIG 0.85 S G
PSIG 1 S G
FEET
CONT DUTY LIMIT WHEN PUMPING
1) - 1.0 SP GR
2) - 0.85 SP GR
3) - 0.72 SP GR
2100 RPM
1800
1500
1200
NPSH - 2100 RPM
NPSH-FEET REQUIRED
US GALLONS PER MINUTE
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

1-10. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES (CONT)


FUEL RETURN VALVE
HANDLE POSITION INDICATES FLOW DIRECTION
AUXILIARY
UNIT TANK
OFF
SUCTION PRESSURE VALVE
DISCHARGE PRESSURE VALVE
NO SMOKING WITHIN 50 FEET (15.2 M)
AUXILIARY CHARGING RECEPTACLE -24 VDC-
CAUTION
HEARING PROTECTION REQUIRED
BATTERY CONNECTION
FUEL SUPPLY VALVE
HANDLE POSITION INDICATES FLOW DIRECTION
UNIT TANK
AUXILIARY
OFF

1-11. DIFFERENCES BETWEEN MODELS

This technical manual covers only the Mainline Pumping Assembly, 800 GPM, Diesel Engine Driven, Part Number 0053009500. No known differences exist for this model number.

1-12. EQUIPMENT DATA

a. *Pump*

Manufacturer	Termomeccanica
Model number	PF3-150/150
Part number	0053009500
Type	Centrifugal
Primary service	Fuel
Secondary service	Water
Output	800 gpm, 1800 ft of head (fluids with specific gravity of 0.85)
Rated driven speed	2100 rpm
Suction (intake) port	6-inch ANSI 300 RF flange
Discharge port	6-inch ANSI 300 RF flange
Priming method	Manual prime
Rotation	Counterclockwise (facing control panel)

b. *Engine*

Manufacturer	Cummins Engine Co.
Model	NTTA-855-P450
Type	Dual turbocharged diesel
Number of cylinders	6
Bore	5 1/2 inches
Stroke	6 inches
Total displacement	855 inches
Horsepower	450 @ 2100 rpm
Direction of rotation (facing flywheel)	Counterclockwise

c. *Capacities*

Engine cooling system capacity	22 gal.
Engine oil capacity	11.0 gal.
Fuel tank capacity	110 gal.

d. *Dimensions and weight*

Overall height (prepared for shipment)	76.7 inches
Overall length	282 inches
Overall width	79.50 inches
Overall height assembled	131.7 inches
Gross weight	14,227 lb uncrated, 17,108 lb crated
Wet weight	18,251 lb

1-13. SAFETY, CARE, AND HANDLING

a. *Before Operation Precautions.* Do not operate the unit in an enclosed area unless the exhaust is piped to the outside. The exhaust contains carbon monoxide, a colorless, odorless, deadly poisonous gas. Do not smoke or use hydrogen, a highly explosive gas. When filling the fuel tank, always maintain a metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting the diesel oil fumes.

b. *During Operation Precautions.* Do not fill the fuel tank while the engine is operating, nor attempt to perform maintenance on the pumping assembly while it is in operation.

c. *After Operation Precautions.* Exercise extreme caution when performing any maintenance while the engine is hot. This may result in serious burns to personnel. When filling the fuel tank, always maintain metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting diesel oil fumes.

d. *Fuel Handling Precautions.* The pumping assembly is capable of pumping petroleum-based liquid fuels. Fuel handling is hazardous. When the pumping assembly is used to pump fuel, equipment and personnel must take precautions against the toxic and combustive characteristics of the fuel and its vapors. Some basic precautions for protecting equipment and personnel during fuel handling operations are listed in the following subparagraphs. These precautions represent minimum considerations for the safe operation of a fuel handling pump. As such, they should be used to augment an existing fuel safety program and in no way limit or reduce the scope of that program. These basic precautions may not be explicitly stated in the manual but are implied.

e. *Combustion Hazard Precautions.* Petroleum-based fuels and their vapors are highly combustible. Improper handling of these fuels can cause an explosion or fire resulting in serious injury or death to personnel and equipment damage. When pumping fuels, observe the following precautions to prevent explosions or fire.

(1) Prohibit smoking except in designated areas. Prohibit matches and lighters in hazardous areas.

(2) Do not wear shoes with exposed nails, metal plates, or hobnails.

(3) Do not carry or wear exposed metal objects, such as knives, keys, or loose identification bracelets that could cause sparks if struck or dropped.

(4) Wear nonstatic clothing, with shirt sleeves rolled down and buttoned, and shirttails tucked in.

(5) Do not carry or wear loose items of clothing.

(6) Keep shirt pockets empty.

(7) Wear leather gloves and all-leather, rubber-soled boots for splash protection.

(8) Never use liquid fuels as cleaning fluids for floors, equipment, clothing, etc.

(9) Fuel vapors are heavier than air and will collect in low places such as pits or sumps; be especially careful in such areas.

(10) Open drums slowly, especially if they have been shaken or exposed to heat, to prevent a fuel-air mixture from spewing out.

(11) Beware of empty (or apparently empty) cans, drums, tanks, and hoses that formerly held fuel. Vapors can remain long after the container has been emptied, and the fuel-air mixture is more likely to be ignited than the liquid alone.

(12) Dispose of oily waste or rags immediately after using by placing in a self-closing metal container.

1-13. SAFETY, CARE, AND HANDLING (CONT)

(13) Avoid spilling fuel; clean up spills at once if they happen. Wipe up small spills or cover with dirt. Follow local emergency procedures for large spills. Treat the area as dangerous until the vapors have gone.

(14) Keep all fuel containers, whether full or empty, tightly closed except when in use.

(15) Report leaks to the proper authorities. Do not operate leaky equipment.

(16) Do not conduct fuel handling operations in a hangar, shop, or other confined area.

(17) Allow at least 150 feet between bulk tank outlets and fuel dispensing points for fire safety.

(18) Use only flashlights, drop lights, or lanterns approved for use in hazardous locations.

(19) Use only explosion-proof electrical equipment and fixtures in hazardous areas; inspect often and correct any conditions that could cause sparking, arcing, or overheating.

(20) Open switches and pull fuses before working on electrical equipment.

(21) Equipment requiring welding and cutting operations must be clean and vapor-free; heaters, welding torches, or blowtorches must not be used within 50 feet of fuel handling operations.

(22) Stop all fuel handling operations during electrical storms.

(23) Bonds and grounds should be tested frequently to ensure conductivity; repair or replace defective parts. Bonds and grounds must be made before fuel flow begins and must not be broken until fuel flow ends.

(24) Vehicles carrying fuel as cargo and those operating within 50 feet of fuel handling operations must be equipped with a spark-arresting exhaust system.

(25) Protective earthworks (berms) around collapsible tanks should be built to give the least possible exposed fuel surface in case of tank rupture. A small area generates the least vapor and provides the smallest burning surface in case of fire.

(26) Do not pump fuel at a rate that will cause severe turbulence.

(27) Do not splash-fill tank trucks or tank cars if top-loading is necessary. Start fill at a slow rate with the filling hose near the tank bottom. When the hose end is submerged, loading can proceed at a full flow rate.

(28) Do not filter fuel through anything other than properly grounded filter separators and monitors.

(29) After filling large tanks, allow several minutes of relaxation time to allow the static charge on the uel surface to equalize with the tank before inserting gages or any other objects into the fuel.

(30) Do not throw or drag hoses and nozzles; avoid kinking hoses.

(31) Turn off radio and radar equipment during fuel handling.

(32) Do not conduct fueling operations within 300 feet of active ground radars.

(33) Do not clip ground wires to antennas, rotor blades, or propeller blades.

(34) Firefighting equipment, including protective clothing, must be in good condition and readily vailable.

1-13. SAFETY, CARE, AND HANDLING (CONT)

(35) Water alone should not be used on a fuel fire since it tends to spread the fire.

(36) Fire extinguishing equipment must be in place and ready during refueling/defueling, including crash crew standby assistance if available.

f. *Toxic Hazard Precautions.* Petroleum-based fuels and their vapors are toxic. Improper handling of these fuels can cause severe irritation or burns to external body parts. Contact with the eyes can cause severe irritation, pain, and blindness. Ingestion of petroleum-based fuels can cause sickness, internal burns, and poisoning. When using this pump unit for pumping fuels, observe the following precautions to prevent bodily injury.

(1) Never use fuel to wash the hands.

(2) Avoid getting fuel on the skin; wash fuel from the skin with soap and water as soon as possible.

(3) If fuel gets into the eyes or mouth, flush thoroughly with water (avoid swallowing) and get medical aid immediately.

(4) If fuel gets on clothing, remove clothing promptly but carefully, wash the skin, and replace clothes with clean items.

(5) Wear leather gloves and all-leather, rubber-soled boots for splash protection.

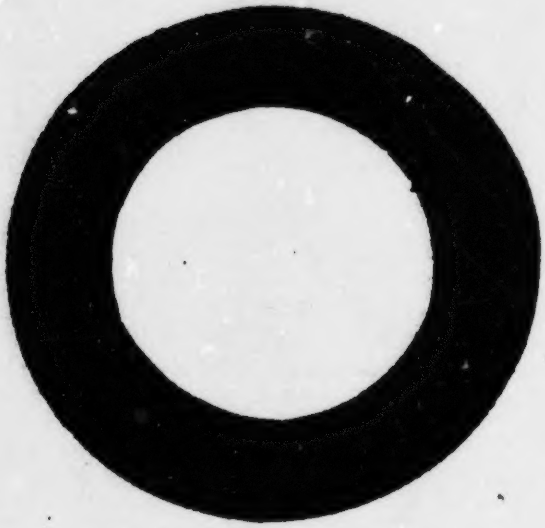
(6) Never use liquid fuels as cleaning fluids for floors, equipment, clothing, etc.

g. *Corrosion Hazard Precautions.* Petroleum-based fuels and their vapors are corrosive to some materials. Some equipment coatings and materials can be damaged by contact or immersion in a petroleum-based fuel. When using this pumping assembly for pumping fuels, observe the following precautions to prevent corrosion damage to equipment.

(1) Do not allow fuel spills or splashes to stand on painted surfaces.

(2) Nonmetallic parts fabricated from rubber, plastic, fabric, and from organic materials may be damaged by prolonged contact or immersion in petroleum-based fuel. Never allow fuel spills or splashes to stand on or cover components made of these materials.

(3) This pumping assembly is painted with Chemical Agent Restive Coating (CARC). CARC gives off toxic fumes when subjected to extreme heat.



CHAPTER 2
UNIT MAINTENANCE INSTRUCTIONS

INTRODUCTION

This chapter contains the following frequently used maintenance information:

a. Lubrication.

b. Information on repair parts; special tools; test, measurement, and diagnostic equipment (TMDE); and support equipment.

c. Instructions for service upon receipt of equipment.

d. Preventive maintenance checks and services (PMCS).

e. Troubleshooting.

f. Maintenance procedures.

g. Preparation for storage or shipment.

Section I. LUBRICATION INSTRUCTIONS

2-1. GENERAL

NOTE

Lubrication is mandatory. No separate lubrication order has been prepared.

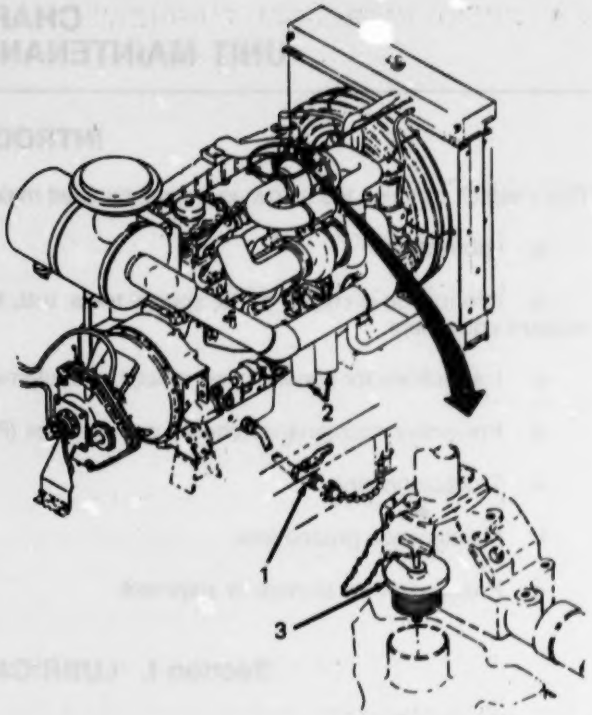
a. *Care of Lubricants.* Keep all lubricants in sealed containers and store in a clean, dry area away from heat. Do not allow foreign materials to come in contact with lubricants. Keep all lubrication equipment clean and ready for use.

b. *Points of Application.* Apply only those lubricants listed in Table 2-1.

Table 2-1. Lubrication Chart

Lubrication Point	Lubrication Type	Frequency
Pump Bearing Oil	MIL-L-46167 Grade Arctic or MIL-L-2104 Grade 15W-40	Change every 4000 operating hours or at least annually.
Speed Increaser Oil	MIL-L-46167 Grade Arctic or MIL-L-2104 Grade 15W-40	Change every 1000 operating hours or at least annually.
Speed Increaser Bearing Grease	No. 2 Lithium Base Grease	Lubricate every 100 hours.
Speed Increaser Pivot Grease	No. 2 Lithium Base Grease	Lubricate monthly.
Engine Oil	MIL-L-46167 Grade Arctic or MIL-L-2104 Grade 15W-40	Change every 250 operating hours or at least semiannually.

2-2. ENGINE LUBRICATION



WARNING

Hot oil can cause serious personal injury.

a. *Oil Drain*

(1) Operate engine until the water temperature reaches 60°C (140°F).

(2) Shut engine off.

NOTE

Drain oil immediately to ensure all the oil and suspended contaminants are removed from the engine.

(3) Turn drain valve (1) to open position.

(4) Turn drain valve to closed position when all oil is drained.

b. *Replace Filters.* Replace the full flow and bypass filters (2).

c. *Oil Fill*

(1) Remove the oil fill cap (3) and add the specified amount of clean 15W-40 oil to fill the oil pan.

(2) Check the oil level on the dipstick. It must be filled to the "H" (high) mark.

(3) Operate the engine until the water temperature reaches 80°C (180°F), and check for oil leaks.

(4) Shut the engine off. Wait 5 to 7 minutes for the oil to drain back to the oil pan.

(5) Check the oil level. Add oil as necessary to bring the level up to the "H" (high) mark on the dipstick.

2-3. SPEED INCREASER LUBRICATION

NOTE

Drain oil while warm.

a. *Oil Drain*

(1) Place a drain pan under oil drain plug (1).

(2) Remove drain plug and drain oil.

(3) Replace drain plug and tighten.

b. *Oil Fill*

(1) Remove oil fill plug (2).

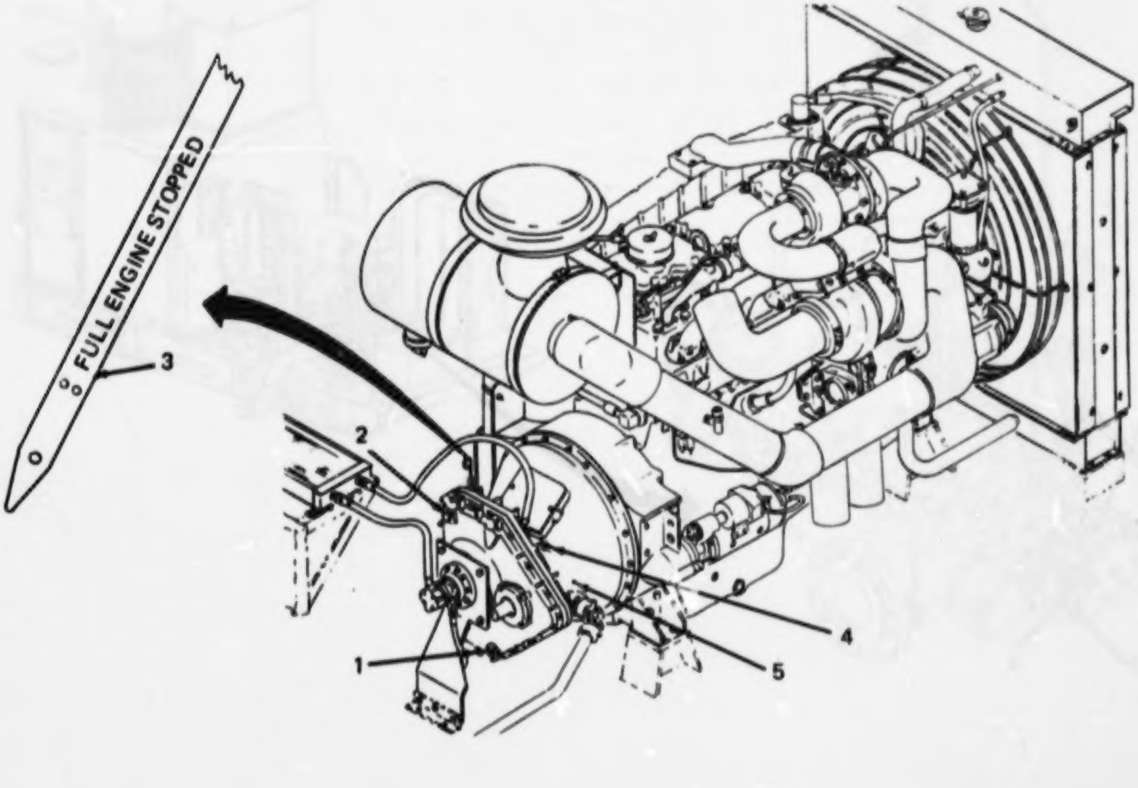
(2) Fill oil sump to full mark on dipstick (3).

(3) Replace oil fill plug and tighten.

c. *Lubricate*

(1) Grease speed increaser bearings (4) with one to two squirts of #2 lithium base grease.

(2) Grease speed increaser pivots (5) with one to two squirts of #2 lithium base grease.



2-4. PUMP LUBRICATION

NOTE

Drain oil while warm.

a. *Oil Drain*

(1) Place a drain pan under oil drain plug (1).

(2) Remove drain plug and drain oil.

(3) Replace drain plug and tighten.

(4) Repeat steps (1) through (3) on opposite bearing housing.

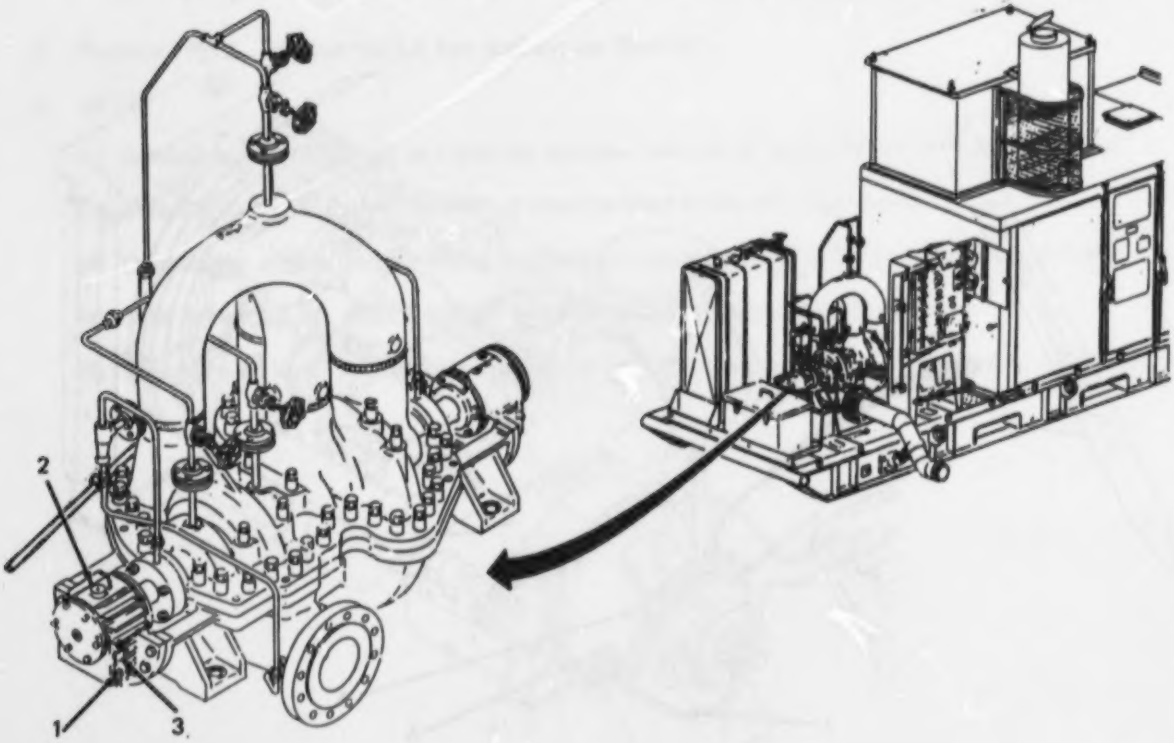
b. *Oil Fill*

(1) Remove oil fill cap (2).

(2) Fill until oil sight glass (3) shows oil sump is full.

(3) Replace oil fill cap.

(4) Repeat steps (1) through (3) on opposite bearing housing.



Section II. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

2-5. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

2-6. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

The special tooling required to service the engine and pump assemblies is listed and illustrated in detail in TM 5-4320-307-24P Repair Parts and Special Tools List (RPSTL).

2-7. REPAIR PARTS

Repair parts are listed and illustrated in TM 5-4320-307-24P.

Section III. SERVICE UPON RECEIPT OF EQUIPMENT

2-8. SITING

Locate the pumping assembly on a hard, flat surface capable of sustaining 17,500 pounds. The pumping assembly should be as close as possible to the liquid source with the suction (inlet) side toward the source.

2-9. UNLOADING EQUIPMENT BY CRANE

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side to side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

Do not attempt to manually roll the pump unit down an inclined ramp.

The complete pumping assembly weighs 17,108 pounds crated with a dry fuel tank. Never attempt to lift the pumping assembly with suction and discharge piping installed or while it is operating.

2-9. UNLOADING EQUIPMENT BY CRANE (CONT)

a. Remove shipping tiedowns.

b. Attach lifting bail assembly to skid.

(1) Enter wood crate through door (1) and remove lifting bail assembly from storage position.

(2) Attach four wires (2) to lifting eyes of skid (3) with four shackles (4).

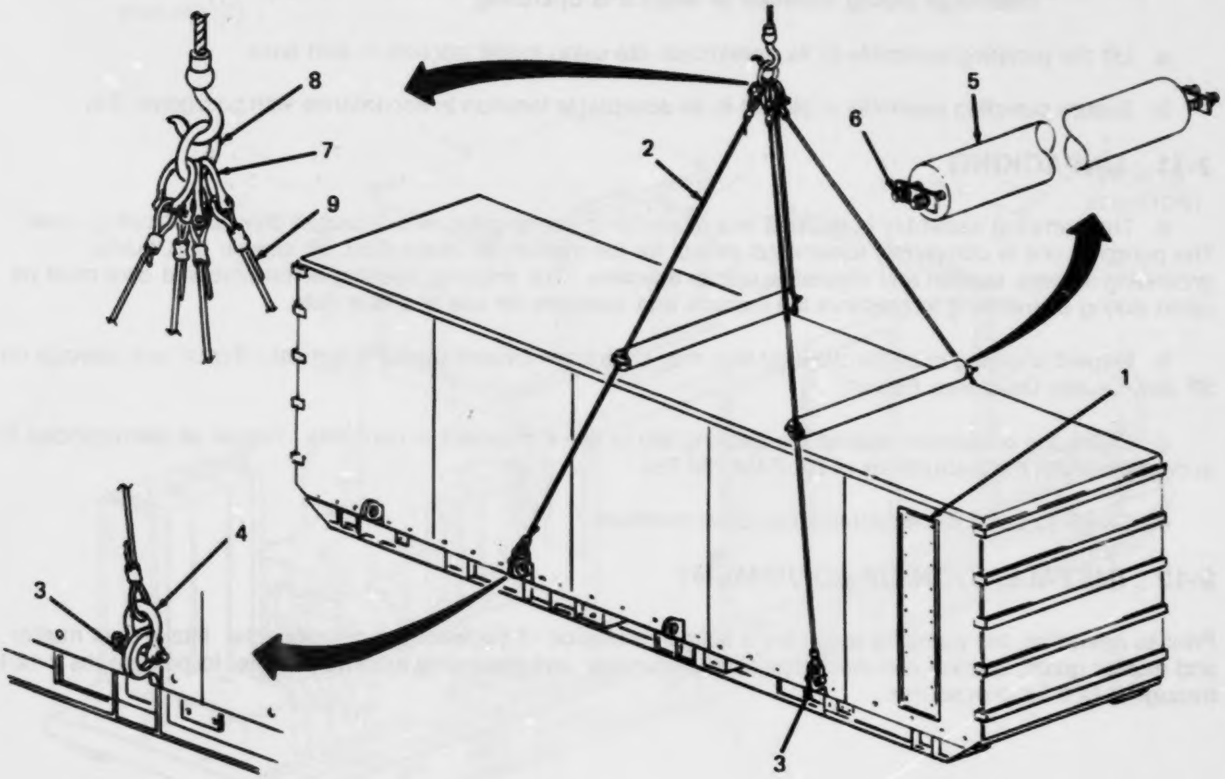
(3) Assemble two spreader bars (5) on wires (2).

(4) Attach spreader bars to wire at marking; tighten nuts (6) on spreader bar so spreader bar does not slide up and down on wire.

(5) Attach two shackles (7) to each small ring of the 20 top triple ring (8).

(6) Secure each shackle to a wire (9).

c. Hoist pumping assembly to its operational site.



2-10. UNLOADING EQUIPMENT BY FORKLIFT

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side to side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

Do not attempt to manually roll the pump unit down an inclined ramp.

The complete pumping assembly weighs 17,108 pounds crated with a dry fuel tank. Never attempt to lift the pumping assembly with suction and discharge piping installed or while it is operating.

a. Lift the pumping assembly to its operational site using forklift pockets in skid base.

b. Ensure pumping assembly is placed in an acceptable location in accordance with paragraph 2-8.

2-11. UNPACKING

a. The pumping assembly is shipped in a close-fitting, rectangular, wood-cleated plywood shipping cover. The pumping unit is completely assembled except for the muffler, air intake duct, air cleaner cap, fluids, grounding system, suction and discharge nozzle adapters. The shipping housing is reusable and care must be taken during dismantling to preserve the material and fasteners for use at a later date.

b. Inspect shipping crate for damage that may have been caused during shipment. Report any damage on SF 364, Quality Deficiency Report.

c. Check the equipment against the packing slip to see if shipment is complete. Report all discrepancies in accordance with the instructions of DA PAM 738-750.

d. Check to see if the equipment has been modified.

2-12. INSTALLATION OF EQUIPMENT

Prior to operation, the pumping assembly requires installation of the following components: intake duct muffler and muffler guard, suction and discharge nozzle adapters, and grounding assembly. Refer to paragraphs 2-12.1 through 2-12.3 for procedures.

2-12.1. INSTALLATION OF INTAKE DUCT MUFFLER AND MUFFLER GUARD

a. *Installation of Intake Duct*

(1) Remove air cleaner rain cap from storage box and install.

(2) Remove screws securing intake duct (1) to storage rack (2).

WARNING

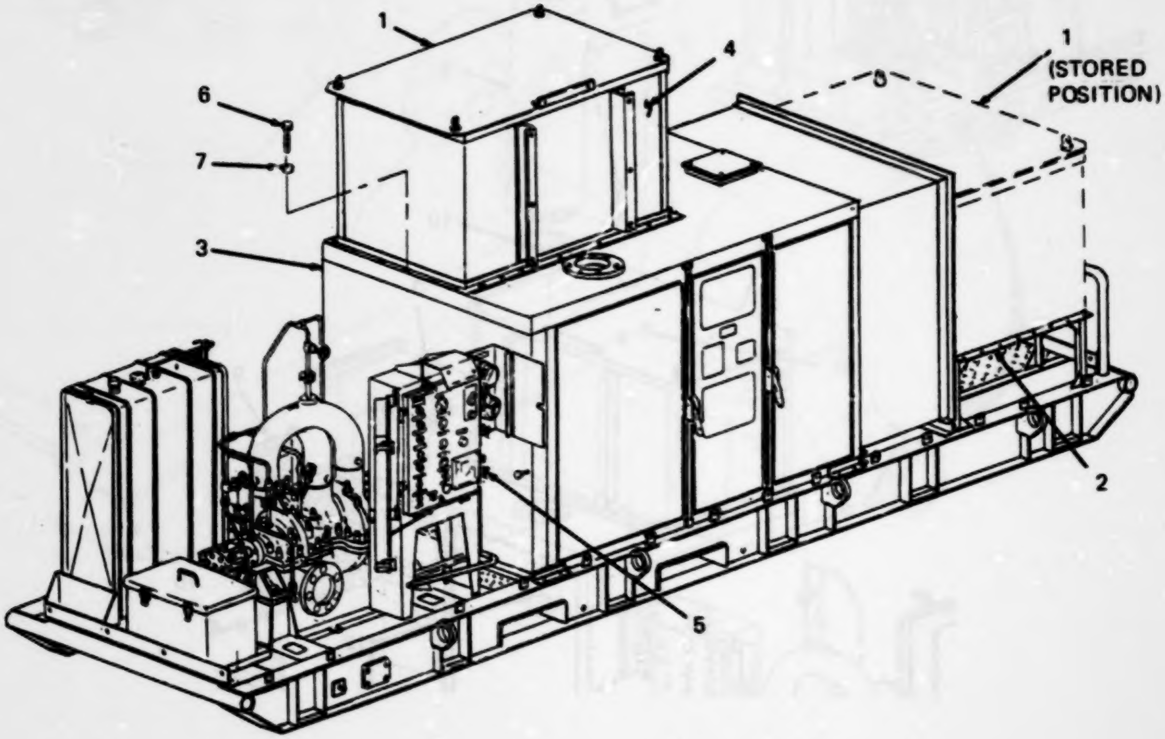
Intake duct weights 275 lbs (124 kg). Use a suitable lifting device to prevent injury to personnel.

(3) Using a suitable lifting device, position the intake duct (1) on top of engine enclosure (3) and air intake port.

NOTE

Ensure the closed side (4) of the intake duct (1) is located on the control panel (5) side of the pump.

(4) Align mounting holes and secure intake duct (1) to engine enclosure (3) with 24 screws (6) and washers (7).



2-12.1. INSTALLATION OF INTAKE DUCT MUFFLER AND MUFFLER GUARD (CONT)

b. *Installation of Muffler and Guard*

(1) Remove muffler (8) and muffler guard (9) from their storage position.

(2) Position gasket (10) on top of engine enclosure exhaust port.

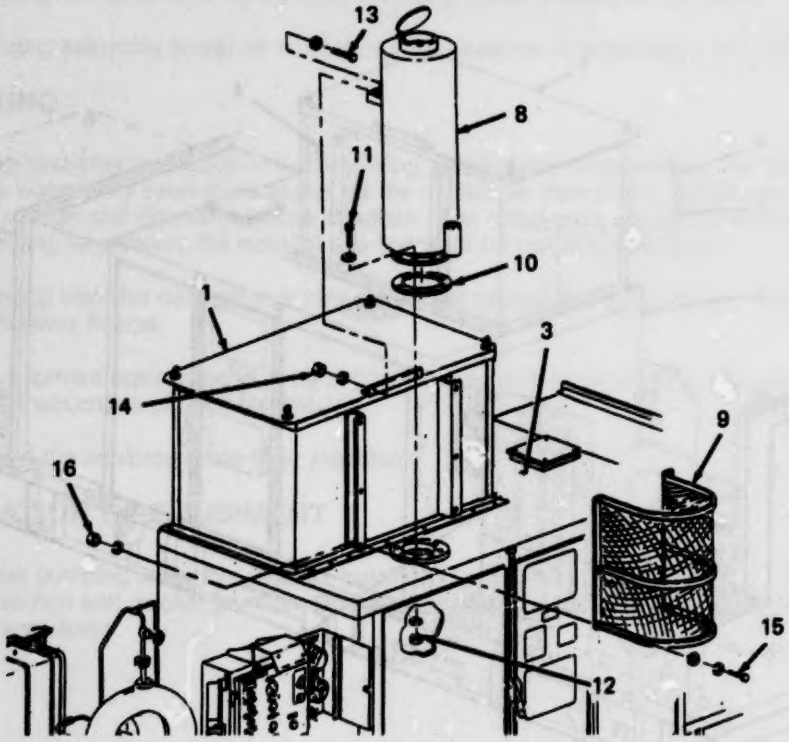
WARNING

Muffler weights 154 lbs (70 Kg). Use a suitable lifting device tc prevent injury to personnel.

(3) Position muffler (8) on top of exhaust port. Align mounting holes and secure to engine enclosure (3) with eight screws and washers (11) and lockwashers and nuts (12).

(4) Secure muffler (8) to intake duct (1) with two screws and washers (13) and lockwashers and nuts (14).

(5) Position muffler guard (9) around muffler (8). Align mounting holes and secure to intake duct (1) with six screws, washers and lockwashers (15) and lockwashers and nuts (16).



2-12.2. INSTALLATION OF SUCTION AND DISCHARGE NOZZLE ADAPTERS

a. Remove flange covers from pump suction and discharge ports.

NOTE

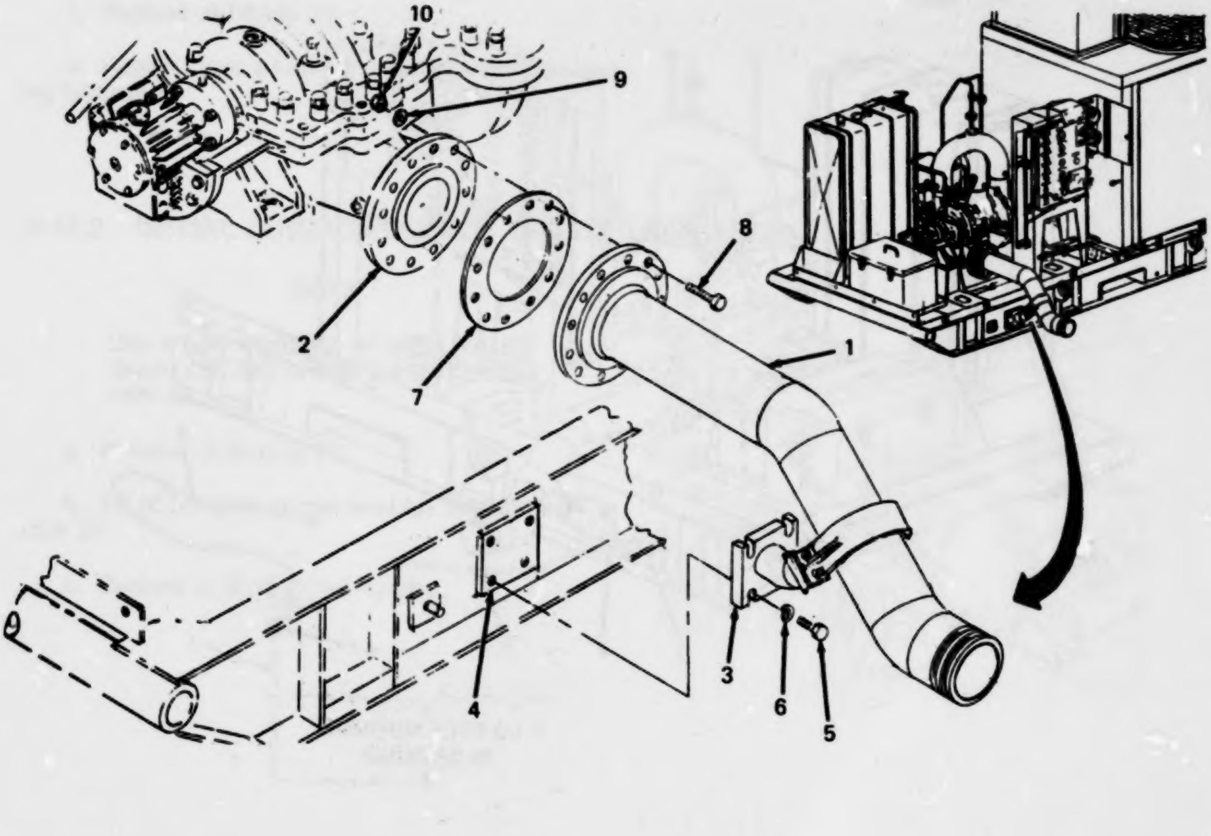
The installation of suction and discharge nozzle adapters are identical. Only the discharge nozzle installation is presented.

b. Remove nozzle adapters (1) from their storage position.

c. Position nozzle adapter at pump flange (2). Align mounting holes on neck and pipe (3) with mounting plate on skid (4). Secure to skid with four screws (5) and washers (6); do not fully tighten.

d. Position gasket (7) on pump flange (2) and then secure nozzle adapter (1) to flange with 12 screws (8), washers (9), and nuts (10).

e. Tighten four screws (5) and washers (6).



2-12.3. INSTALLATION OF GROUNDING ASSEMBLY

a. Remove grounding rods and cables from storage position.

b. Install grounding assembly as follows:

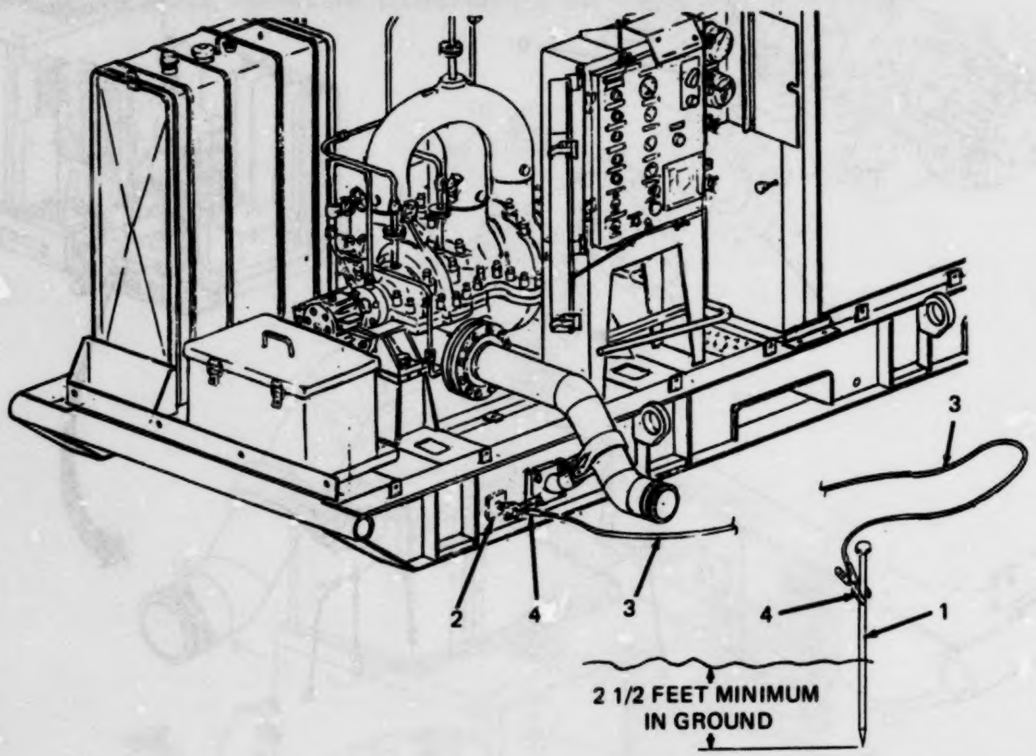
NOTE

The earth surrounding ground rods must be moist to make a good electrical connection. In dry or sandy areas, pour water around the rods to improve the connection.

(1) Drive grounding rods (1) into ground within 6 feet of each skid grounding pad (2) (one pad on each side of skid).

(2) Drive ground rods (1) to a minimum depth of 2-1/2 feet (0.762 m) into the ground.

(3) Connect each skid grounding pad to corresponding grounding rod using the 6-foot uninsulated grounding wire (3). Be sure connectors (4) have made tight electrical connection.



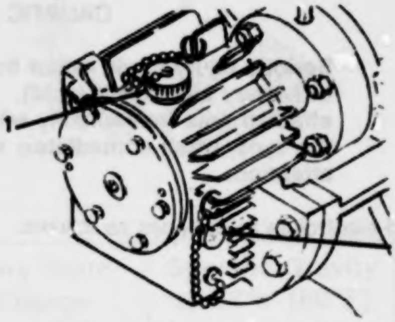
2-13. PRELIMINARY SERVICING AND ALIGNMENT

Prior to operation, the pumping assembly requires servicing of the following components and systems: pump, speed increaser, battery, engine fuel system, engine lubrication system, engine air connections, and engine coolant. Refer to paragraphs 2-13.1 through 2-13.7 for procedures. Refer to chapter 3 for alignment and installation of the pump and speed increaser shafts.

2-13.1. INITIAL LUBRICATION OF PUMP

NOTE

Use pump bearing oil MIL-L-46167 Grade ARCTIC or MIL-L-2104 Grade 15W-40.



a. Remove oil fill cap (1).

b. Fill until oil sight glass (2) shows oil sump is full.

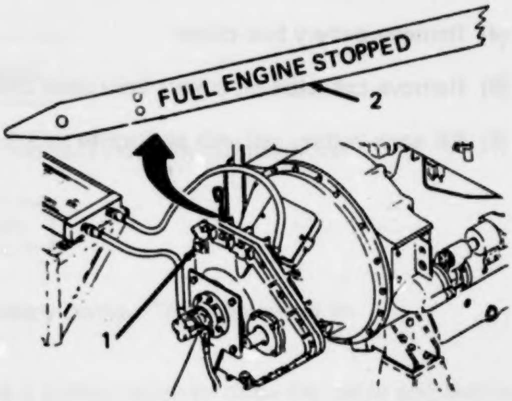
c. Replace oil fill cap (1).

d. Repeat steps a through c for opposite side bearing lubrication.

2-13.2. INITIAL LUBRICATION OF SPEED INCREASER

NOTE

Use speed increaser oil MIL-L-46167 Grade ARCTIC or MIL-L-2104 Grade 15W-40.



a. Remove oil fill plug (1).

b. Fill oil sump to proper level full mark on dipstick (2).

c. Replace oil fill plug and tighten.

2-13.3. BATTERY SERVICING AND CABLE CONNECTION

WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

CAUSTIC CHEMICALS IN BATTERIES

Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

a. Add electrolyte to batteries as follows:

NOTE

Maintenance free batteries are sealed and do not require the addition of electrolyte.

If conventional batteries are used, proceed with the following instructions.

(1) Remove electrolyte from storage location.

(2) Using a hydrometer, check electrolyte specific gravity. Reading must be 1.265-1.280.

(3) Open battery box clips.

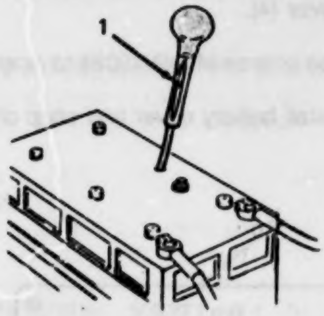
(4) Remove battery box cover.

(5) Remove cell caps on covers from each cell.

(6) Fill each battery cell with electrolyte to 3/8-inch (9.5 mm) above cell plates.

2-13.3. BATTERY SERVICING AND CABLE CONNECTION (CONT)

(7) Use hydrometer (1) to measure the specific gravity of each cell.



NOTE

If specific gravity of any or all of the cells is below 1.200, the battery must be charged using a battery charger (2).

(8) Refer to chart to determine the battery state-of-charge based on the specific gravity readings.

Battery State of Charge	Specific Gravity @ 27°C [80°F]
100%	1.260-1.280
75%	1.230-1.250
50%	1.200-1.220
25%	1.170-1.190
Discharged	1.110-1.130

b. Connect battery cables as follows:

WARNING

When connecting battery cables always connect positive terminal first.

CAUTION

Avoid making contact across the two battery posts. This can result in severe arcing.

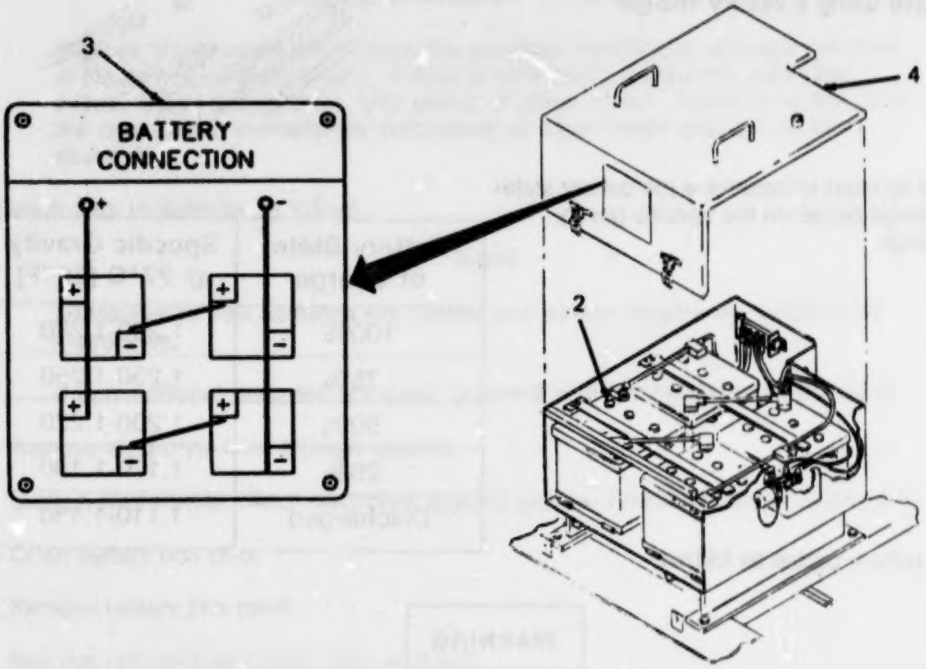
(1) If connections are coated with preservative, use a battery brush to clean the cable and battery terminals.

2-13.3. BATTERY SERVICING AND CABLE CONNECTION (CONT)

(2) Install and tighten the battery cables in accordance with battery connection label (3) on battery cover (4).

(3) Use grease MIL-G-10924 to coat the battery terminals to prevent corrosion.

(4) Install battery cover and snap clips.



2-13.4. PRIMING ENGINE FUEL SYSTEM

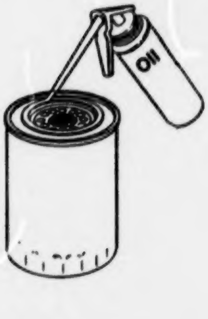
a. Prime engine fuel filters as follows:

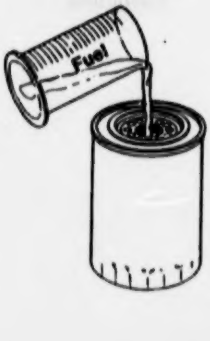
(1) Using a filter wrench, remove both fuel filters.

(2) Using a clean lint free towel, clean the filter head gasket surfaces.

(3) Apply a light film of clean engine oil to the filler gasket surfaces.

(4) Fill the filters with clean fuel.





2-13.4. PRIMING ENGINE FUEL SYSTEM (CONT)

(5) Install the filters on the filter heads. Tighten the filters until the gaskets contact the filter head surface.

(6) Tighten the filter an additional one-half to three-fourths (1/2 to 3/4) turn after the gasket contacts the filter head surface.

b. Prime engine fuel pump as follows:

(1) Remove plug (1) from the top of the fuel pump housing (2).

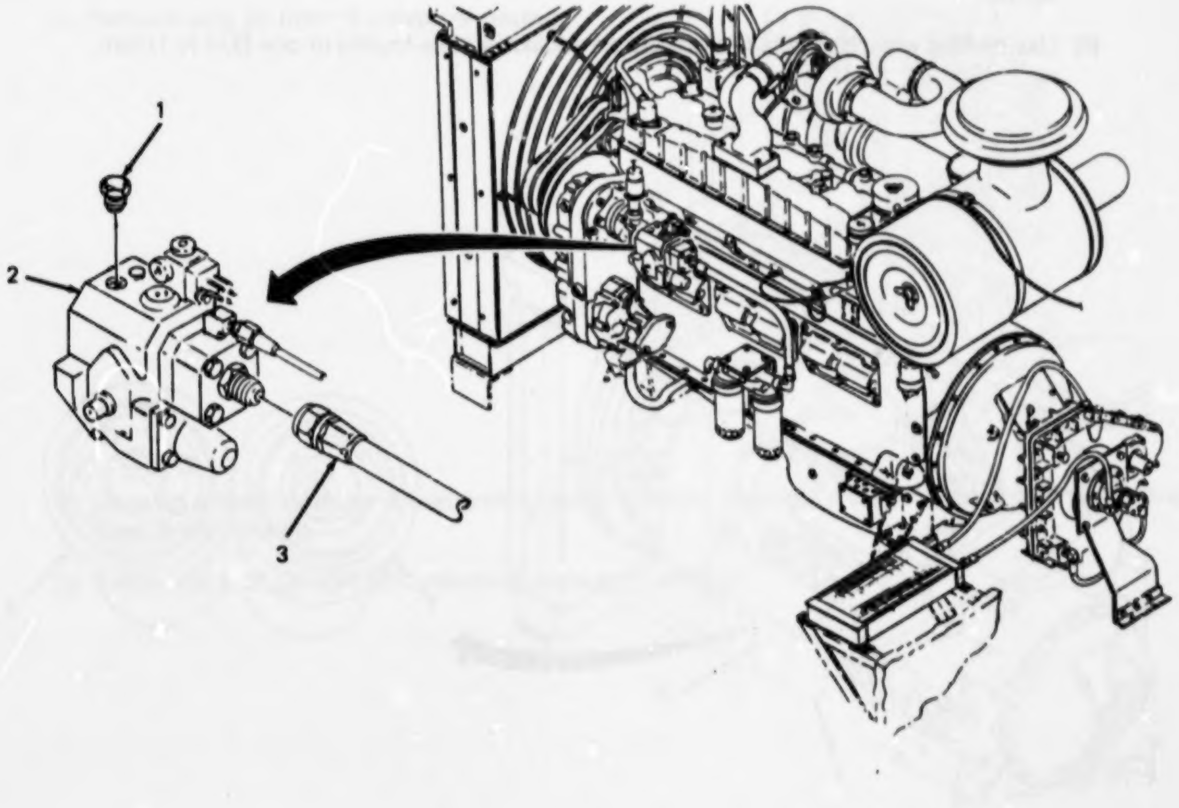
(2) Fill the housing with clean fuel oil.

(3) Re-install plug (1) and tighten the plug to 22 ft lbs (30 N·m) torque.

(4) If the priming plug is hard to remove or the fuel pump is a VS type, remove the fuel supply hose (3) to the fuel pump.

(5) Fill the fuel pump with clean engine lubricating oil.

(6) Install the supply hose to the fuel pump.



2-13.5. PRIMING ENGINE LUBRICATION SYSTEM

a. Prime oil filters as follows:

NOTE

The external appearance of the bypass filter (1) and the full flow filter (2) is the same. The internal differences are different as shown.

(1) Using oil filter wrench, remove the bypass filter (1) and full flow filter (2).

(2) Clean the oil filter head surface.

(3) Use clean engine oil to lubricate the gasket surface of the filters.

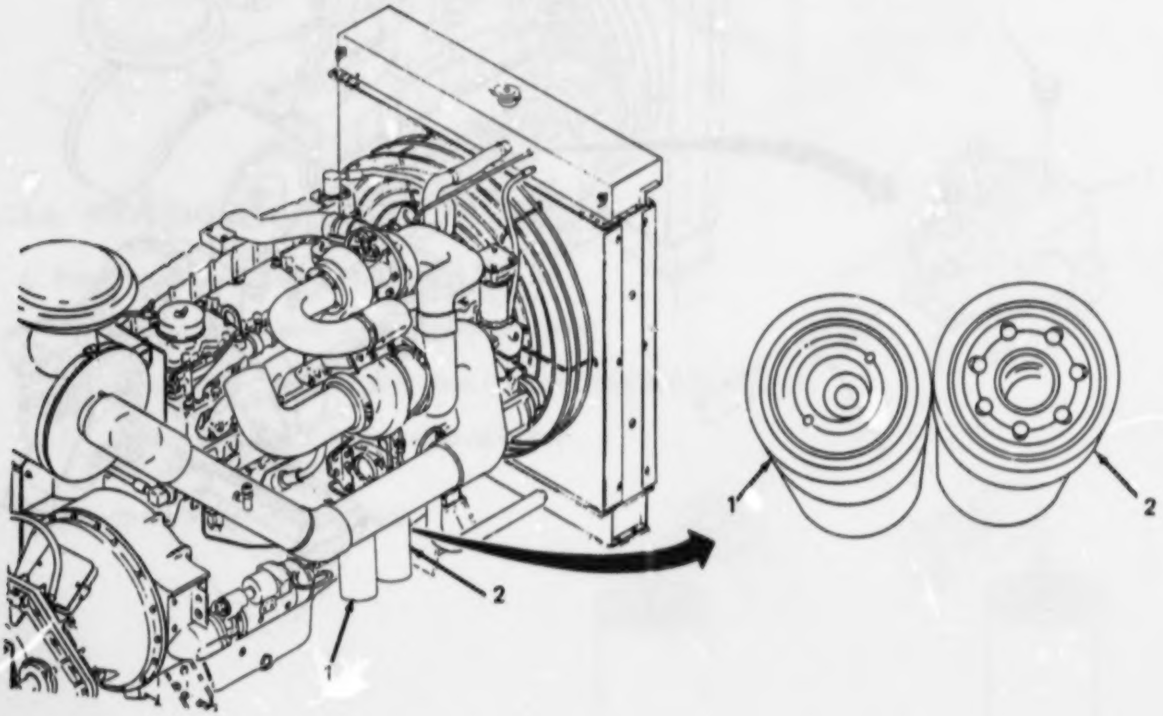
(4) Fill filters with clean engine oil.

CAUTION

Mechanical overtightening may distort the threads or damage the filter element seal.

(5) Install the filters on the oil filter head. Tighten the filters until the gasket contacts the filter head surface.

(6) Use oil filter wrench to tighten the filters an additional three-fourths to one (3/4 to 1) turn.



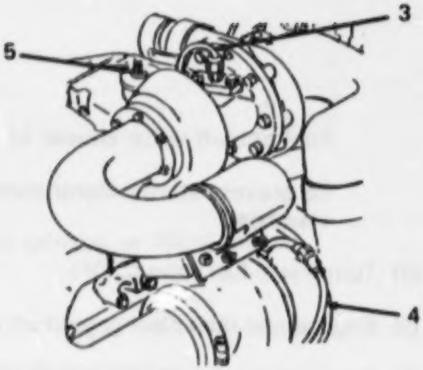
2-13.5. PRIMING ENGINE LUBRICATION SYSTEM (CONT)

b. Lubricate turbocharger bearings as follows:

(1) Remove oil inlet hoses (3 and 4).

(2) Pour 50 to 60 CC (2.0 to 3.0 ounces) of clean engine oil into the turbocharger oil supply tube fittings (5).

(3) Reconnect hoses and tighten swivel nuts to 22 ft. lbs (30 N•m) torque.



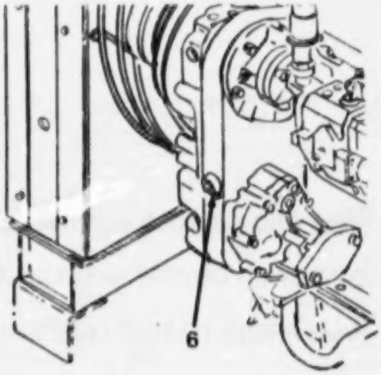
c. Add oil to engine as follows:

(1) Remove oil fill cap.

(2) Add enough clean engine oil to fill crankcase to L (low mark on dipstick).

d. Prime engine lubrication system as follows:

(1) Remove plug (6) from oil crossover passage.



(2) Connect a hand- or motor-driven priming pump line from a source of clean lubricating oil to the plug boss in the housing.

(3) Prime until a 30 psi (207 kPa) minimum pressure is obtained.

2-13.5. PRIMING ENGINE LUBRICATION SYSTEM (CONT)

e. Rotate crank shaft as follows:

CAUTION

Fuel shutoff valve should be closed or disconnected to prevent starting.

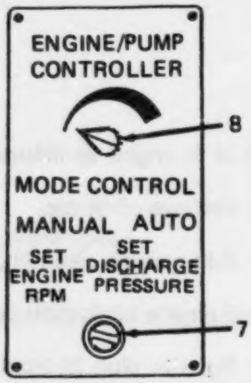
To prevent starter motor damage, do not crank engine for more than 30 seconds.

(1) Turn 3-way fuel valve to OFF.

(2) Engage and then disengage clutch lever.

(3) Set control panel MODE CONTROL switch (7) to MANUAL.

(4) Turn ENGINE/PUMP CONTROLLER knob (8) fully counterclockwise to set ENGINE RPM position.



(5) Place ENGINE STOP switch in push position.

(6) Set POWER ON/OFF switch to ON.

(7) Press PRESS TO TEST LAMPS switch. Alarm lights should come on and then go off.

(8) Verify clutch is disengaged (down).

CAUTION

To prevent starter motor damage, do not crank engine for more than 30 seconds.

(9) Press ENGINE START switch. Rotate crankshaft for at least 15 seconds while maintaining external oil pressure of at least 15 psi (103 kPa).

2-13.5. PRIMING ENGINE LUBRICATION SYSTEM (CONT)

f. Remove external oil supply as follows:

(1) Remove the external oil supply and replace the plug.

(2) Tighten plug to 60 - 70 ft lbs (81 - 95 N•m) torque.

CAUTION

Clean the area of any lubricating oil spilled while priming or filling the crankcase.

g. Add oil to engine as follows:

(1) Remove oil fill cap and fill crankcase to H (high mark on dipstick).

(2) Replace fill cap.

2-13.6. INITIAL INSPECTION OF AIR CONNECTIONS

a. Visually inspect for loose or damaged intake air piping, air crossovers and turbocharger to after cooler air supply hoses.

b. Tighten all loose clamps to 70 in lbs (8 N•m) torque.

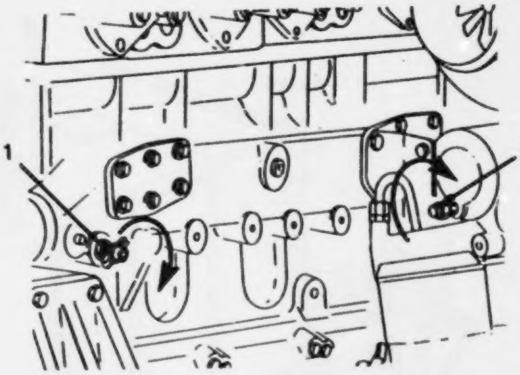
2-13.7. INITIAL FILL OF ENGINE COOLANT

a. Ensure radiator drain cock is closed.

b. Tighten all hose clamps to 40 in lbs (5 N•m) torque.

c. Ensure engine draincocks (1) are closed.

d. Ensure oil cooler draincocks (2) are closed.



NOTE

Ensure the coolant filter is tight.

e. Use a mixture of 50 percent ethylene glycol antifreeze and 50 percent water to fill the cooling system.

2-13.7. INITIAL FILL OF ENGINE COOLANT (CONT)

f. Fill the cooling system with coolant to the bottom of the fill neck in the radiator fill (or expansion) tank.

g. Install the radiator fill cap.

NOTE

Engine coolant level should be checked again after engine has reached operating temperature and been allowed to cool below 120°F (50°C).

2-13.8 ALIGNMENT OF PUMP AND SPEED INCREASER SHAFTS AND COUPLING INSTALLATION

NOTE

Prior to coupling assembly installation, the pump and speed increaser gear half couplings must be aligned. Notify direct support maintenance of installation and alignment requirements.

Section IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

2-14. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Table 2-2 lists the preventive maintenance checks and services which shall be performed at specified intervals by unit maintenance personnel. It expands upon the preventive maintenance services performed by operator/crew maintenance and includes additional services which are allocated to unit maintenance. The columns, codes, and location designations used in the table are as follows:

a. Item numbers are assigned to each check or service task. These numbers are to be used as a source of item numbers for the TM Number column on DA form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.

b. The service intervals are divided into four categories: H - Hours, W - Weekly, S - Semiannually, and A - Annually. A dot (●) is placed in the interval column for each check or service. If the same check or service is made in two or more intervals, a dot is placed in each applicable column.

c. The Item To Be Inspected column lists the item to be checked or serviced.

d. The Procedure column describes the procedure by which the check or service is to be performed. Illustrations are included to assist in locating that part of the equipment requiring the check or service.

e. The designations left, right, front, and rear as used in PMCS indicate the side of end of the pump assembly as viewed when facing the control panel.

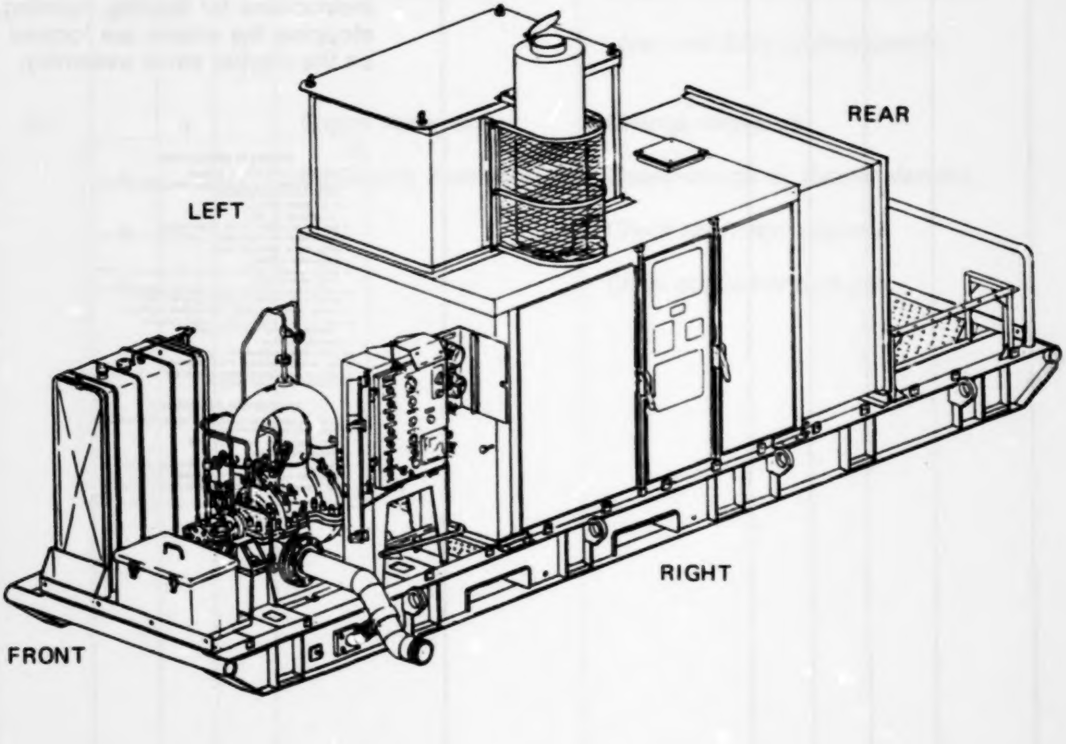


Table 2-2. Unit Preventive Maintenance Checks and Services

H - Hours
W - Weekly

S - Semiannually
A - Annually

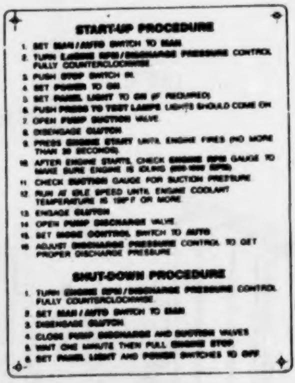
Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		

CAUTION

During PMCS it is necessary to run the engine to be sure that the work has been accomplished satisfactorily. Since the pump is coupled to the engine through the speed increaser gear, the pump will run when the clutch is engaged. Do not operate the pumping assembly unless the pump casing is filled to the top of the suction port. The pump will not prime when dry. Extended operation of a dry pump will destroy the seal assembly and cause overheating which could seriously damage the pump.

NOTE

Instructions for starting, running, and stopping the engine are located on the control panel assembly.



START-UP PROCEDURE

1. SET MAN/AUTO SWITCH TO MAN
2. TURN ENGINE RPM/DISCHARGE PRESSURE CONTROL FULLY COUNTERCLOCKWISE
3. PUSH STOP SWITCH IN.
4. SET POWER TO ON
5. SET PANEL LIGHT TO ON (IF REQUIRED)
6. PUSH PRESS TO TEST LAMPS LIGHTS SHOULD COME ON
7. OPEN PUMP SUCTION VALVE
8. DISENGAGE CLUTCH
9. PRESS ENGINE START UNTIL ENGINE FIRES (NO MORE THAN 30 SECONDS)
10. AFTER ENGINE STARTS, CHECK ENGINE RPM GAUGE TO MAKE SURE ENGINE IS IDLING ([illegible] RPM)
11. CHECK SUCTION GAUGE FOR SUCTION PRESSURE
12. RUN AT IDLE SPEED UNTIL ENGINE COOLANT TEMPERATURE IS [illegible] OR MORE
13. ENGAGE CLUTCH
14. OPEN PUMP DISCHARGE VALVE
15. SET MODE CONTROL SWITCH TO AUTO
16. ADJUST DISCHARGE PRESSURE CONTROL TO GET PROPER DISCHARGE PRESSURE

SHUT-DOWN PROCEDURE

1. TURN ENGINE RPM/DISCHARGE PRESSURE CONTROL FULLY COUNTERCLOCKWISE
2. SET MAN/AUTO SWITCH TO MAN
3. DISENGAGE CLUTCH
4. CLOSE PUMP DISCHARGE AND SUCTION VALVES
5. WAIT ONE MINUTE THEN PULL ENGINE STOP
6. SET PANEL LIGHT AND POWER SWITCHES TO OFF

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
1	4000			●	Pump Assembly	Check pump bearing oil.
2			●		Batteries, Battery Cables, and Battery Box	Clean battery terminals, terminal lugs, and cables.
3			●		In-field Instrument Layout	Check transducers for damage or loose mountings.
						Check transducer wiring for secure attachment and broken or frayed insulation or wires.
4	1000			●	Speed Increaser	Change speed increaser oil.
	40					Lubricate speed increaser pivot shaft.
	100					Lubricate speed increaser ball bearing collar.
5	250		●		Radiator Assembly	Check engine coolant concentration.
				(2 yrs)		Clean and flush cooling system.
6	250		●		Engine Assembly	Change engine oil.
7		●			Air Cleaner Assembly	Clean/change air cleaner element.
		●				Check restriction indicator.
		●				Clean precleaner dust pan.

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
8			●		Turbocharger	**WARNING** **Do not remove the air inlet and exhaust elbows while the engine is running. Touching a moving impeller could cause serious injury.** **Objects entering the turbine and compressor chambers could seriously damage the turbocharger, and fragments ejected from the chambers could cause serious eye injuries.** **Severe burns can be caused by turbocharger and exhaust system heated during operation of the engine. If the engine has been running, do not touch the turbocharger or exhaust system components until they have cooled.** Loosen hose clamps (1) and pull air inlet pipe (2) from turbocharger (3).

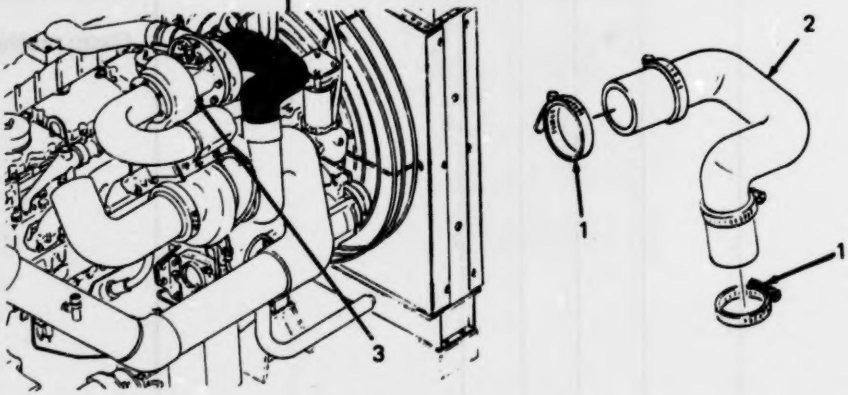


Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

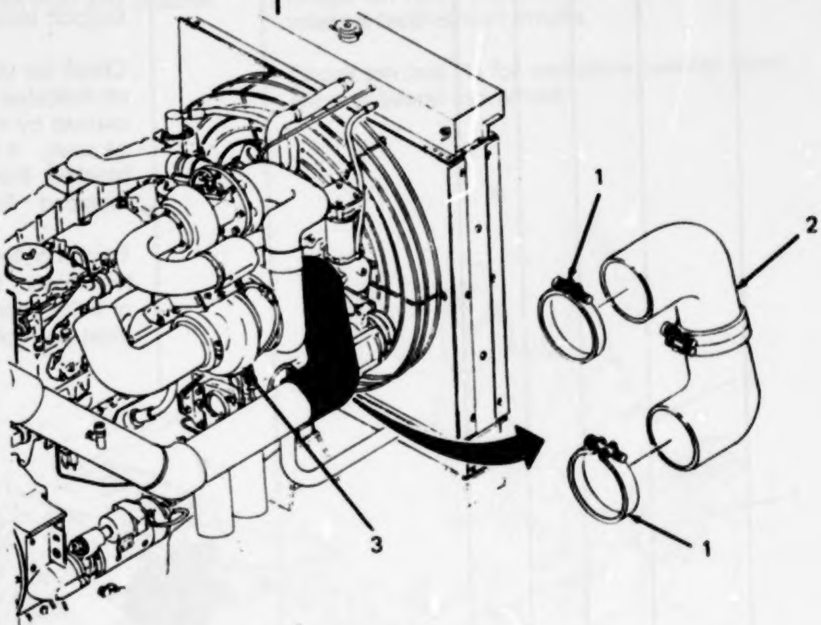
Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
8					Turbocharger (Cont)	Loosen clamps (1) securing air inlet pipe (2) to turbocharger (3).  **CAUTION** Do not remove carbon or dirt build-up from the compressor or turbine impellers. The turbocharger must be disassembled to thoroughly clean the impellers. Even small deposits remaining on the blades unbalance the impeller and damage the turbocharger.

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

Item No.	Interval H	Interval W	Interval S	Interval A	Item To Be Inspected	Procedure
8					Turbocharger (Cont)	Check for carbon or dirt buildup on impellers (1) and casing port. If buildup is present, the turbocharger must be cleaned. Notify direct support maintenance. Check for oil on impellers (1). The presence of oil indicates seal leaks. Oil seal leaks are caused by blocked air intake ducts or damaged oil seals. If the air filter and intake ducts are not blocked, the turbocharger oil seals must be replaced. Notify general support maintenance. Turn impellers (1) by hand. Impellers should turn freely. If impellers scrape the casing wall, or if the impeller shaft binds, the turbocharger must be replaced or repaired.

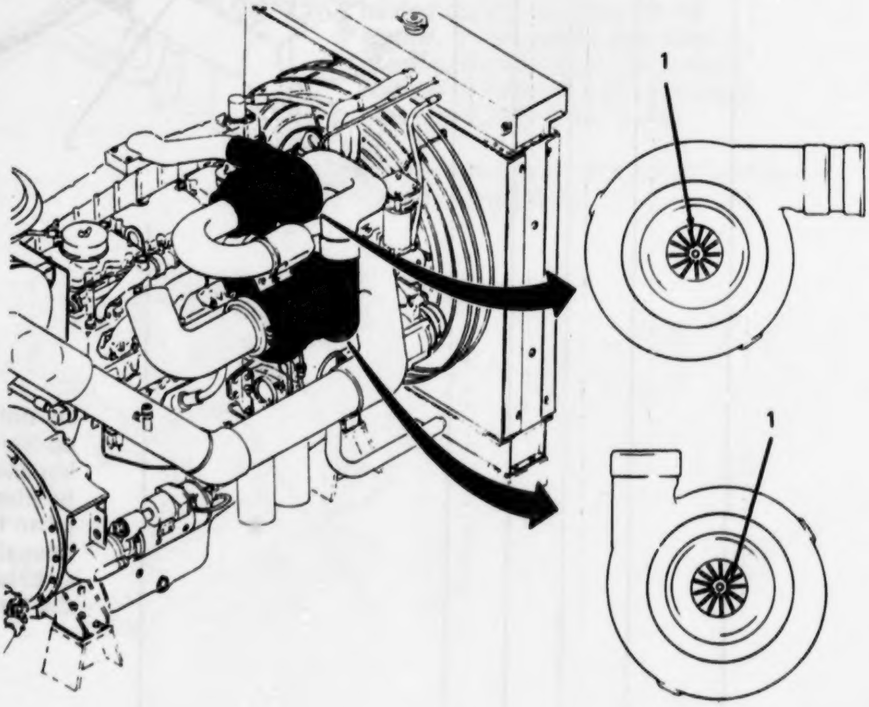


Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
9	250		●		Coolant Filter	Replace coolant filter.
10			●		Fan Hub and Bracket	Check fan hub (1) and bracket (2) for loose or missing hardware or cracks. Check fan hub (1) for excessive bearing clearance or lateral movement.

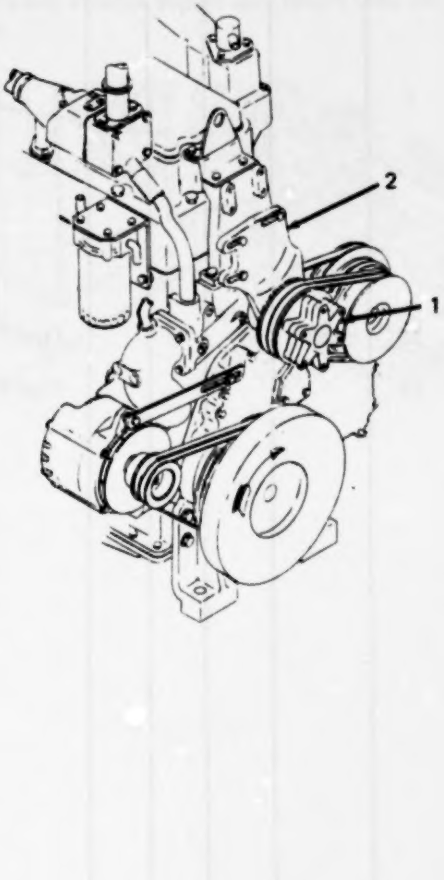


Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

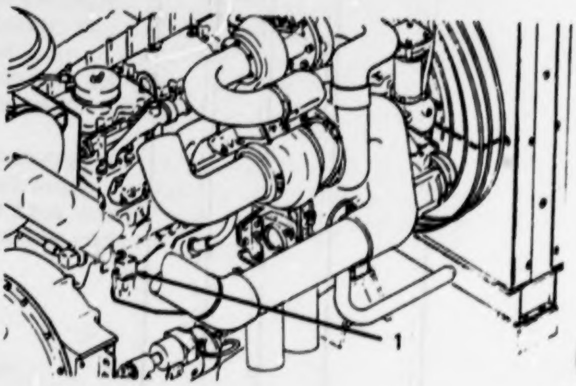
Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
11			●		HVT Valve Assembly	Check HVT valve assembly (1) for loose or missing hardware. Check for leaks around hose connections and HVT valve seams. 
12	250		●		Fuel Filter Assembly	Change fuel filters.
13	1600				Fuel Pump Assembly	**WARNING** **Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engine must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engine near open fuel containers. DO NOT SMOKE.** Service fuel pump assembly.

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

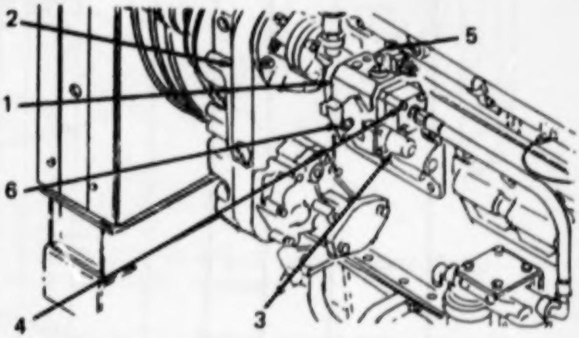
Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
13			●		Fuel Pump Assembly (Cont)	Check that fuel pump (1) is securely mounted to engine (2). Check for leaks between the pump mounting flange and engine (2). Check idle spring pack (3), fuel pump damper (4), shutoff valve (5), and throttle lever (6) for secure attachment to fuel pump (1). Check fuel injector supply and return lines for leaks. 

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

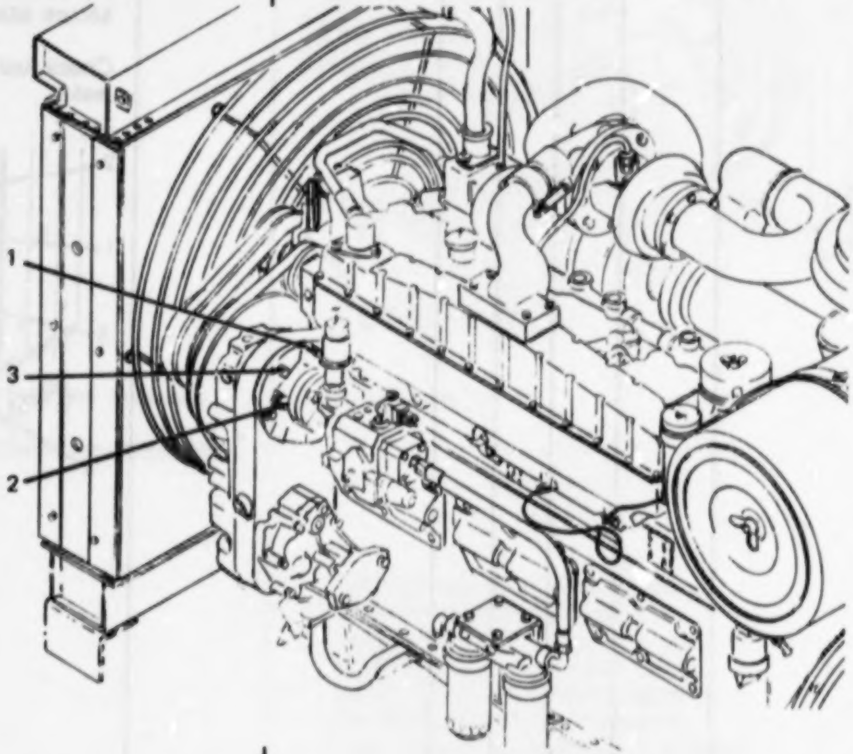
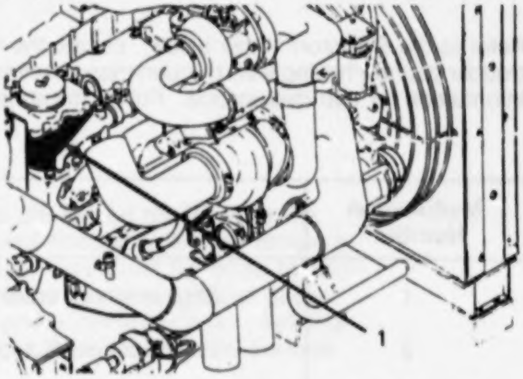
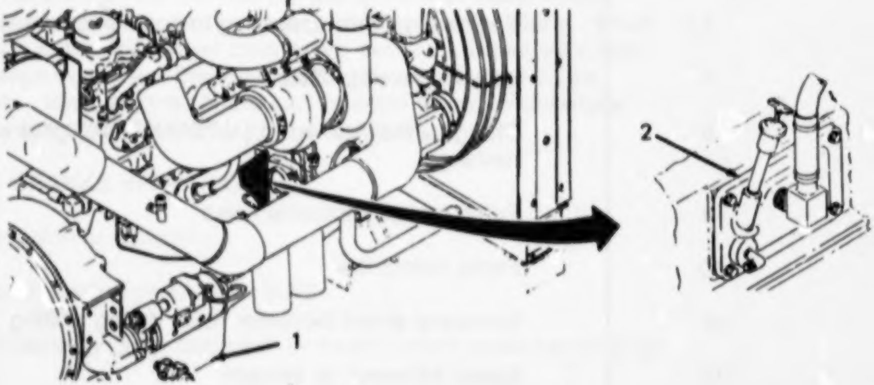
Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
14			●		Accessory Drive Assembly	Check accessory drive assembly (1) for loose or missing hardware. Check for leaks at mating surface of fuel pump (2). Check for cracks at mounting flanges (3). 
15	250				Lube Oil Cooler Assembly	Replace lube oil filter elements.

Table 2-2. Unit Preventive Maintenance Checks and Services (Cont)

H - Hours
W - Weekly

S - Semiannually
A - Annually

Item No.	Interval				Item To Be Inspected	Procedure
	H	W	S	A		
16			●		Rocker Lever Housing Assembly	Check rocker lever housing assembly (1) for loose or missing hardware. Check for leaks at top and bottom of rocker lever housing assembly (1).
	1500			●		Adjust rocker levers. 
17			●		Oil Pan and Oil Gage Bracket	Check oil pan (1) and oil gage bracket (2) for loose or missing hardware. Check oil pan (1) and oil gage bracket (2) for leaks at mating surfaces. 

Section V. TROUBLESHOOTING

2-15. TROUBLESHOOTING

a. Table 2-3 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of unit maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of unit maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to TM 5-4320-307-10.

2-16. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the pumping assembly. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks very slowly	2-35
2	Engine cranks but fails to start	2-36
3	Engine runs unsteadily and power output is low	2-37
4	Engine starts but pump suction gage or pump discharge gage does not function	2-38
5	Dense exhaust smoke after warmup	2-38
6	Engine overheats according to engine coolant temperature gage	2-39
7	Low engine oil pressure	2-39
8	Charging indicator lamp (ALTERNATOR) lights when engine is running	2-40
9	Pump makes excessive noise	2-40
10	Pump output low	2-41
11	Excessive speed increaser noise during shifting	2-41
12	Speed increaser oil leakage	2-42

Malfunction Number	Description	Page
13	Speed increaser does not respond to shift lever movement	2-42
14	Oil thrown from filler tube	2-42
15	Excessive pump noise	2-42
16	Excessive pump vibration	2-42

Table 2-3. Unit Maintenance Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

WARNING

Troubleshooting procedures may require that checks be made while the engine is running. Use extreme care to prevent contact with high temperature exhaust, electrical or moving parts. Proper care must be taken to provide efficient ventilation when running the engine indoors; exhaust gases contain carbon monoxide which is odorless and a deadly poison. Spilling diesel fuel on or about a hot engine may cause an explosion and serious injury.

CAUTION

During some troubleshooting procedures it may be necessary to run the engine and pump assembly. Do not run the pump without water in the volute. This will destroy the mechanical seal, causing pump failure. When necessary to run the pump for longer than a few seconds, make sure that suction and discharge hoses are installed and a source of water to be pumped is available. Start engine, prime and operate pump to duplicate normal operation and to prevent pump from overheating.

1. ENGINE FAILS TO CRANK OR CRANKS VERY SLOWLY

Step 1. Check fuse for corrosion or damage.

Replace fuse in control panel (para 2-28).

Step 2. Check for weak batteries or dirty, corroded, or loose battery cable connections.

Add distilled water as needed. Recharge batteries or replace if defective (para 2-27).

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 3. Check for dirty, corroded, or loose cable connections on alternator and starter (para 2-42 and 2-43).

Clean and tighten starter and/or alternator connections if necessary.

Step 4. Check V-belts for breaks or cracks. Check belt tension.

Tighten or replace V-belts as necessary (para 2-41).

Step 5. Remove and check starter.

Replace defective starter (para 2-43).

Step 6. If engine still will not crank, the engine may be seized.

Notify direct support maintenance.

2. ENGINE CRANKS BUT FAILS TO START

Step 1. Check air cleaner intake restriction indicator for red band indicating blocked air cleaner elements.

If red band appears in air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements (para 2-38).

Step 2. Be sure that fuel tank vent is not clogged or restricted. A closed vent will cause a vacuum in the fuel tank and not allow fuel to flow freely to the fuel feed pump.

If vent is clogged, dislodge debris being careful not to contaminate the fuel.

Step 3. Check alinement of 3-way selector valve.

Aline 3-way selector valve to open position (refer to TM 5-4320-307-10).

Step 4. Check for empty fuel tank.

If fuel tank is empty, fill with diesel fuel oil and bleed air from fuel system.

Step 5. Check fuel supply to injectors.

If there is no fuel flow, replace fuel filter as described in paragraph 2-51.

Step 6. Check air inlet and turbocharger for obstructions, carbon or dirt buildup on turbocharger impellers, or oil leaks.

Notify direct support maintenance.

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 7. During cold weather operations check cold starting aid.

Replace ether bottle (para 2-37).

3. ENGINE RUNS UNSTEADILY AND POWER OUTPUT IS LOW

Step 1. Check air cleaner intake restriction indicator for red band indicating blocked air cleaner elements.

If red band appears in air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements (para 2-38).

Step 2. Be sure that fuel tank vent is not clogged or restricted. A closed vent will cause a vacuum in the fuel tank and not allow fuel to flow freely to the fuel feed pump.

If vent is clogged, dislodge debris being careful not to contaminate the fuel.

Step 3. Check fuel supply to injectors.

If there is no fuel flow, replace fuel filter as described in paragraph 2-51.

Step 4. Check air inlet and turbocharger for obstructions, carbon or dirt buildup on turbocharger impellers, or oil leaks.

Notify direct support maintenance.

Step 5. Check turbocharger plumbing and oil feed lines for damage or obstructions.

If there is no oil flow through oil feed line, replace oil feed lines (para 2-39).

Step 6. Check turbocharger mounting.

Tighten mounting bolts (para 2-40).

Step 7. Check engine exhaust system for obstructions.

Remove obstructions from exhaust system.

Step 8. Check magnetic pickup wiring for continuity, breaks, burrs, or fraying. Check for loose or damaged connectors.

Replace wires or connectors if broken or damaged (para 2-28 and 2-30).

Step 9. Check field instrument layout wiring for continuity, breaks, burrs, or fraying. Check for loose or damaged connectors.

Replace wires or connectors if broken or damaged (para 2-30).

Step 10. Notify direct support maintenance.

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

---

4. ENGINE STARTS BUT PUMP SUCTION GAGE OR PUMP DISCHARGE GAGE DOES NOT FUNCTION

Step 1. Check that suction and discharge valves are in open position.

Open valves.

Step 2. Gauge is damaged.

Replace gauge (para 2-28).

5. DENSE EXHAUST SMOKE AFTER WARMUP

Step 1. Shut down engine. With engine level, check oil.

Step 2. Check air cleaner intake restriction indicator for red band indicating blocked air cleaner elements.

If red band appears in air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements (para 2-38).

Step 3. Check air intake piping for damage or obstructions.

Remove obstructions; repair or replace (para 2-38).

Step 4. Check turbocharger for leaking oil seals.

If air filter and intake ducts are not blocked, replace turbocharger.

6. ENGINE OVERHEATS ACCORDING TO ENGINE COOLANT TEMPERATURE GAGE

Step 1. Check coolant level.

WARNING

Care should be taken when removing radiator cap. Steam or hot coolant under pressure may cause injury to personnel.

CAUTION

Do not add coolant when engine is hot. Internal engine damage could result.

If coolant level is low, fill to proper level (para 2-35).

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 2. Inspect water pump drivebelt for looseness, absence, and worn out condition.

a. If belt deflects more than 3/4 in. (1.8 cm) or less than 1/2 in. (1.3 cm), adjust (para 2-41).

b. If belt is missing or worn out, install new belt (para 2-41).

Step 3. Inspect radiator, water pump, hoses and hose connections, and draincocks for leaks.

a. Tighten hose clamps and fittings.

b. Replace defective cooling system components.

c. Tighten or close draincocks.

d. Replace radiator or water pump if leaks are detected (para 2-35 and 2-50).

Step 4. Inspect fan for cracked and missing blades.

Replace fan if necessary (para 2-48).

Step 5. Check radiator for airflow obstructions.

Remove obstructions from front of radiator.

Step 6. Test thermostat for proper operation.

Replace thermostat if defective (para 2-45).

Step 7. Check aftercooler for obstructions.

If there is no coolant flow through aftercooler, remove aftercooler and clean aftercooler core (para 2-47).

Step 8. Check coolant filter assembly.

Replace filter if necessary (para 2-44).

7. LOW ENGINE OIL PRESSURE

Step 1. Shut down engine and check oil system for leaks. Check rocker lever cover and oil drain assembly for leaks. Check for damaged and leaking oil lines and fittings. Check inside control panel cover assembly for evidence of leakage from oil pressure indicator or oil pressure line hose. Check lube oil cooler for leaks. Examine area of crankcase directly below lube oil cooler. If leaks cannot be easily detected and engine can be run without damage, clean the engine as described below. After engine is clean, start the engine and observe lubrication system for leaks.

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protection equipment.

a. Remove accumulated dust and dirt with compressed air.

b. Tighten loose components. Replace leaking components (para 2-52) and start engine. If cover, front cover, or associated surfaces, other than fittings or fasteners, are leaking, notify direct support maintenance.

8. CHARGING INDICATOR LAMP (ALTERNATOR) LIGHTS WHEN ENGINE IS RUNNING

Step 1. Check for weak batteries or dirty, corroded, or loose battery cable connections.

Add distilled water as needed. Recharge batteries or replace if defective (para 2-27).

Step 2. Check V-belts for breaks or damage. Check belt tension. Check for damaged or frozen pulleys (para 2-48).

Tighten or replace V-belts as necessary (para 2-41).

Step 3. Check alternator.

Test/inspect alternator, replace alternator as required (para 2-42).

9. PUMP MAKES EXCESSIVE NOISE

Step 1. Check that suction and discharge valves are open.

Relocate suction hose connection below surface of liquid. Keep suction intake off of bottom when pumping (refer to TM 5-4320-307-10).

Step 2. Check suction pipe, connections, or parting surface of suction flange for leaks.

Step 3. Check engine RPM. High RPM will cause pump cavitation.

Reduce engine speed to meet suction capability.

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 4. Check for pump cavitation.

a. Reduce suction lift and/or friction losses in suction line.

b. Open suction valves to reduce pumped fluid dissolved gases.

Step 5. Check for the pumping of air.

Locate and eliminate source of air bubble.

Step 6. Check pump body and suction piping for foreign material.

a. Remove suction and discharge piping and check for obstructions (para 2-56).

b. Inspect pump body for any foreign material or obstruction.

10. PUMP OUTPUT LOW

Step 1. Be sure pump is properly primed.

Step 2. Check that engine speed is properly adjusted for desired flow and conditions.

Adjust engine speed.

Step 3. Check that suction and discharge valves are fully opened.

Open all suction and discharge valves.

Step 4. Check for a loose connection or defective gasket in suction or discharge lines.

a. Tighten connection (para 2-56).

b. Replace gasket (para 2-56).

Step 5. Inspect piping for leaks.

Replace piping.

Step 6. Check that speed increaser is fully engaged.

Fully engage speed increaser.

11. EXCESSIVE SPEED INCREASER NOISE DURING SHIFTING

Step 1. Check speed increaser oil level.

Add or replace as necessary (para 2-34).

Table 2-3. Unit Maintenance Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

12. SPEED INCREASER OIL LEAKAGE

Step 1. Check drain plug for leaks.

a. Tighten plug 15 - 20 ft-lb (20 - 27 N•m).

b. Replace drain plug.

c. If leak continues, notify direct support maintenance.

Step 2. Check all housing gaskets for leaks.

a. Tighten all bolts.

b. If leak continues, notify direct support maintenance.

13. SPEED INCREASER DOES NOT RESPOND TO SHIFT LEVER MOVEMENT

Step 1. Check oil level.

Add oil as necessary (para 2-34).

Step 2. Check shift lever connection.

Tighten; repair as necessary.

14. OIL THROWN FROM FILLER TUBE

Step 1. Check fluid level for overfilling.

Drain oil to proper level.

15. EXCESSIVE PUMP NOISE

Step 1. Check oil level.

a. Fill to proper level.

b. Tighten filler plug 35 ft-lb (47 N•m).

c. Notify direct support maintenance.

16. EXCESSIVE PUMP VIBRATION

Step 1. Check oil level.

a. Fill to proper level.

b. If vibration continues, notify direct support maintenance.

Section VI. MAINTENANCE PROCEDURES

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2-17. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following.

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and START/STOP switch set at STOP. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix D to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in the procedure. Standard torque values given in Appendix D are determined by thread size.

2-18. ENGINE EXHAUST SYSTEM REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection c. Repair d. Installation e. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable hoist and sling

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Exhaust gasket

Personnel Required

Two

Manual References

TM 5-4320-307-10

General Safety Instructions

Engine shutdown and cool

Well-ventilated area required

REMOVAL:

WARNING

Handling hot exhaust system can cause severe burns. Allow unit to cool before handling.

1 Remove six screws (1), washers (2), lockwashers (3), and nuts (4) securing muffler guard (5) around muffler (6).

2 Remove two screws (7), washers (8), lockwashers (9), and nuts (10) securing muffler (6) to intake duct (11).

3 Remove eight screws (12), washers (13), lockwashers (14), and nuts (15) securing muffler (6) to top of exhaust port (16).

WARNING

The muffler weighs 154 lbs (70 kg). Use a suitable lifting device to prevent injury to personnel.

4 Remove muffler (6). Discard gasket (17).

2-18. ENGINE EXHAUST SYSTEM REPAIR/REPLACE (CONT)

CLEANING/INSPECTION:

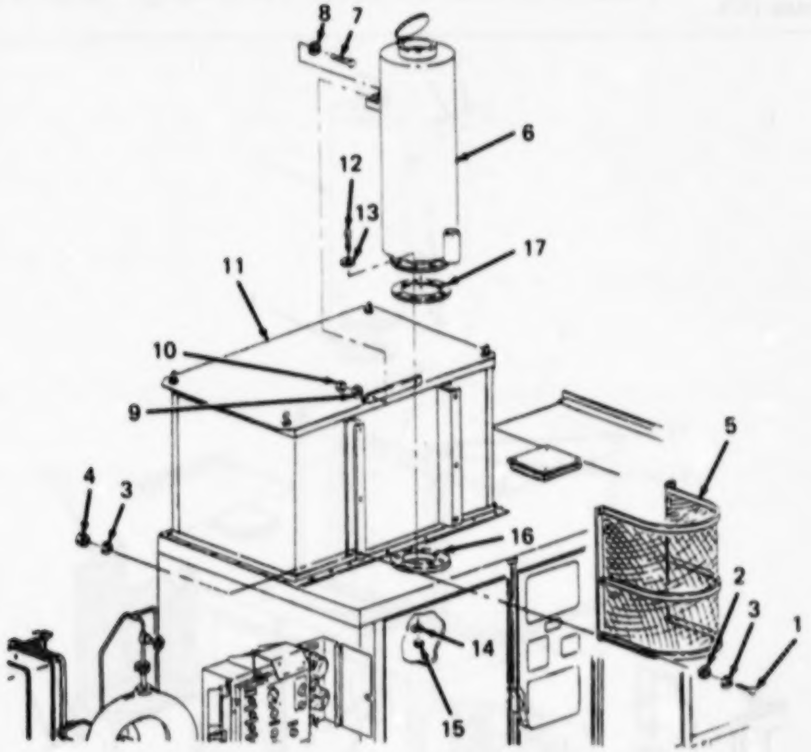
WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm²) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean muffler guard with dry cleaning solvent and dry with compressed air. Inspect for minor rust, corrosion, or other damage. Replace if severely rusted or damaged.

2 Inspect muffler for damage or erosion that would prevent exhaust gas to escape. Replace muffler if muffler is severely damaged or eroded.



2-18. ENGINE EXHAUST SYSTEM REPAIR/REPLACE (CONT)

REPAIR:

1 Repair minor dents, rust, or corrosion on muffler guard.

2 Straighten or replace bent clamps, mounting bands, or muffler bracket.

3 Replace muffler if holes or tears are present or if severely dented or corroded.

INSTALLATION:

WARNING

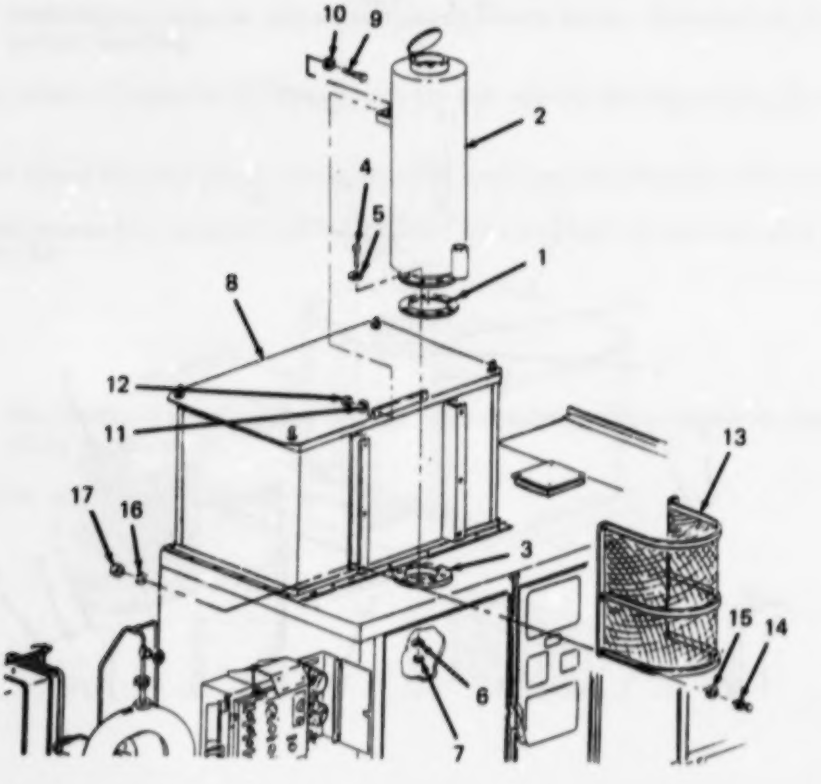
The muffler weighs 154 lbs (70 kg). Use a suitable lifting device to prevent injury to personnel.

1 Position gasket (1) and muffler (2).

2 Secure muffler (2) to top of exhaust port (3) using eight screws (4), washers (5), lockwashers (6), and nuts (7).

3 Secure muffler (2) to top of intake duct (8) using two screws (9), washers (10), lockwashers (11), and nuts (12).

4 Position muffler guard (13) around muffler (2) and secure using six screws (14), washers (15), lockwashers (16), and nuts (17).



2-18. ENGINE EXHAUST SYSTEM REPAIR/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU.

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air, keep warm and still, give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Start engine in accordance with procedures in TM 5-4320-307-10, and observe muffler and muffler guard for leaks and/or looseness or rattles. Tighten screws, clamps, and bands as necessary.

2-19. BAIL LIFTING ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Install/Stow

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable hoist and sling

Materials/Parts

Dry cleaning solvent (Item 25, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

Soft cloth

Personnel Required

Two

Special Environmental Conditions

Well ventilated area required for cleaning.

REMOVAL:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Be sure hoisting equipment is suitable for the size of the load. Total weight of lifting bail assembly is approximately 245 lbs.

1 Secure a suitable lifting device to triple ring (1).

NOTE

If lifting bail is in stowed position, prepare to remove. If lifting bail is connected to skid assembly, remove slack.

2 Raise lifting bail assembly (2) to a height convenient for cleaning, inspection, repair, or replacement of component parts.

2-19. BAIL LIFTING ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

1 Inspect triple ring (1) for overall condition.

2 Inspect shackles (3) for overall condition.

3 Ensure that nuts (4) are not loose or corroded.

WARNING

Use protective gloves while checking cable. Failure to do so could result in personal injury.

4 Slide a heavy rag along cable (5) and check for fraying, corrosion, and overall condition. Replace cable if fraying is found.

WARNING

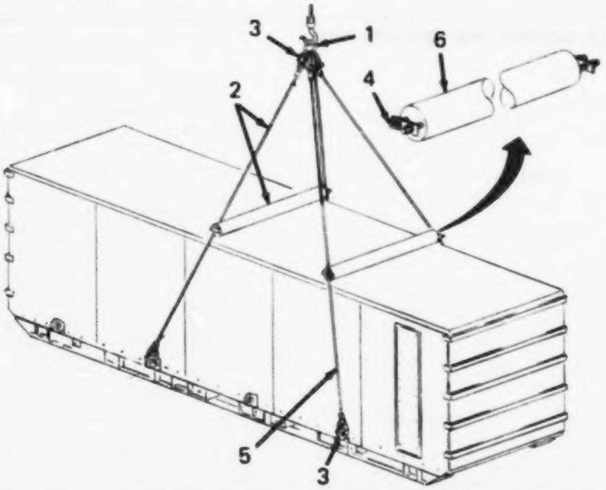
Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

5 Inspect spreader bar (6) for corrosion, nicks, and burrs. Smooth with crocus abrasive cloth. Clean with drycleaning solvent and refinish surfaces. Replace parts if severely damaged.

INSTALL/STOW:

1 If lifting bail assembly (2) is to be stowed, remove spreader bars and secure to rear of skid assembly (side opposite pump) using U-bolts provided.

2 If lifting bail assembly (2) is to remain attached to skid, remove lifting device and allow triple ring (1) to rest on top of enclosure or container.



2-20. GROUNDING ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection c. Repair d. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Cloth

Crocus abrasive cloth (Item 1, Appendix C)

General Safety Instructions

Pumping assembly not operating

REMOVAL:

1 Remove clamps (1) from each skid grounding pad (2) and ground rod (3).

2 Remove ground rod (3) from ground.

CLEANING/INSPECTION:

1 Clean components by wiping with a clean rag.

2 Inspect clamps (1) for good clamping action. Check for good connection with ground wire (4).

3 Inspect ground wire (4) for broken or frayed insulation.

4 Inspect ground rods (3) for bends or corrosion.

REPAIR:

1 Remove corrosion on clamps, ground rods using crocus abrasive cloth. Replace clamps if clamping action is not secure.

2 Repair connection between clamps and ground wire.

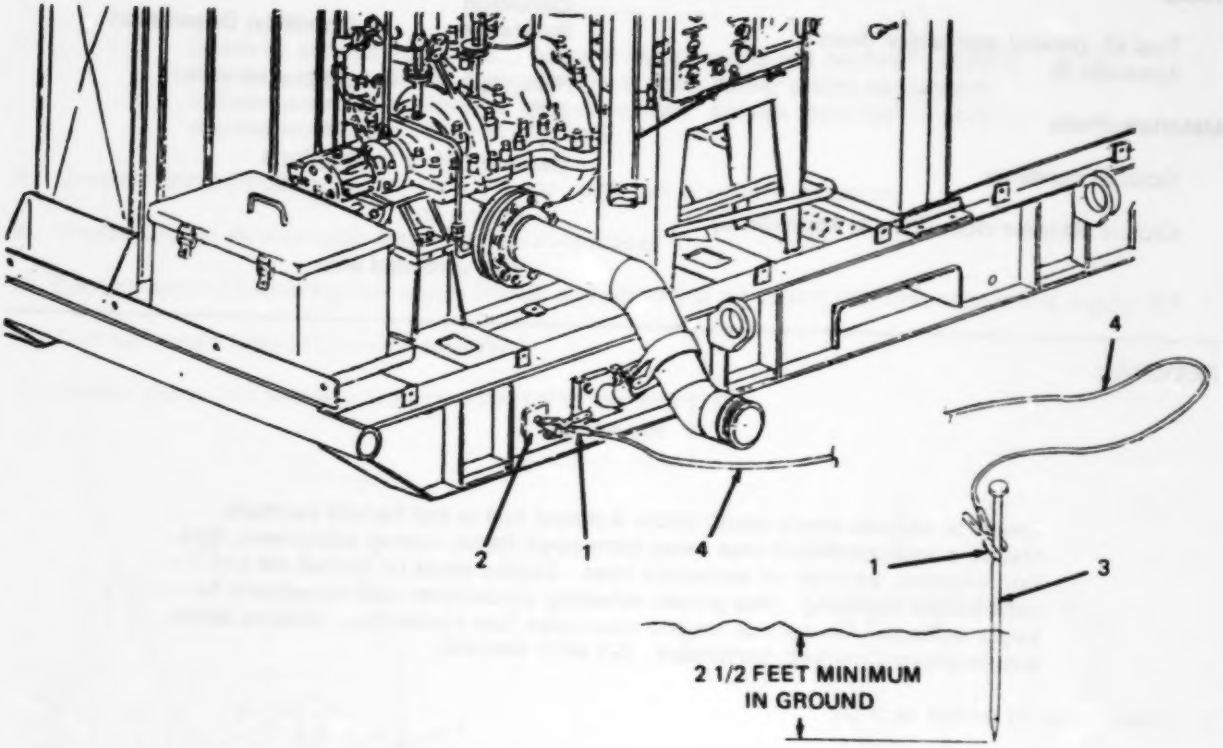
3 Repair bends.

2-20. GROUNDING ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:

1 Drive ground rods (3) into ground within 6 feet of each skid grounding pad.

2 Install clamp (1) to each skid grounding pad (2) and ground rod (3).


4
2
1
4
1
3
2 1/2 FEET MINIMUM IN GROUND

2-21. FEEDING SYSTEM REPAIR/REPLACE

This task covers: a. Removal b. Inspection c. Installation d. Bleeding Fuel System

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Suitable container

Crocus abrasive cloth (Item 1, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-27	Battery box removed

General Safety Instructions

Engine cool

Well ventilated area

REMOVAL:

WARNING

Death or serious injury could occur if diesel fuel is not handle carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Engine must be turned off and cool before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engine near open fuel containers. Always store fuel in proper, marked containers. DO NOT SMOKE.

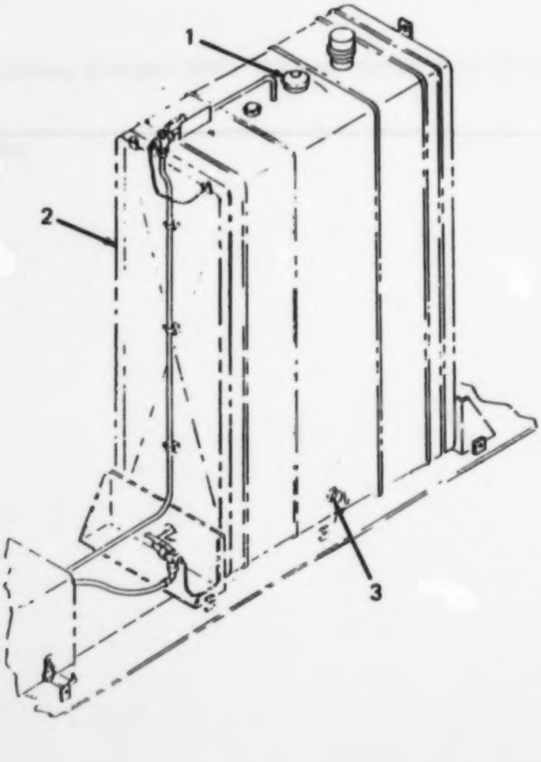
1 Loosen cap (1) on fuel tank (2).

2 Remove drain plug (3).

3 Drain fuel into a suitable container.

4 Install drain plug (3).

5 Tighten cap (1).



2-21. FEEDING SYSTEM REPAIR/REPLACE (CONT)

6 Turn fuel supply valve (4) to OFF position.

7 Place a suitable container under fuel supply valve (4).

WARNING

Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

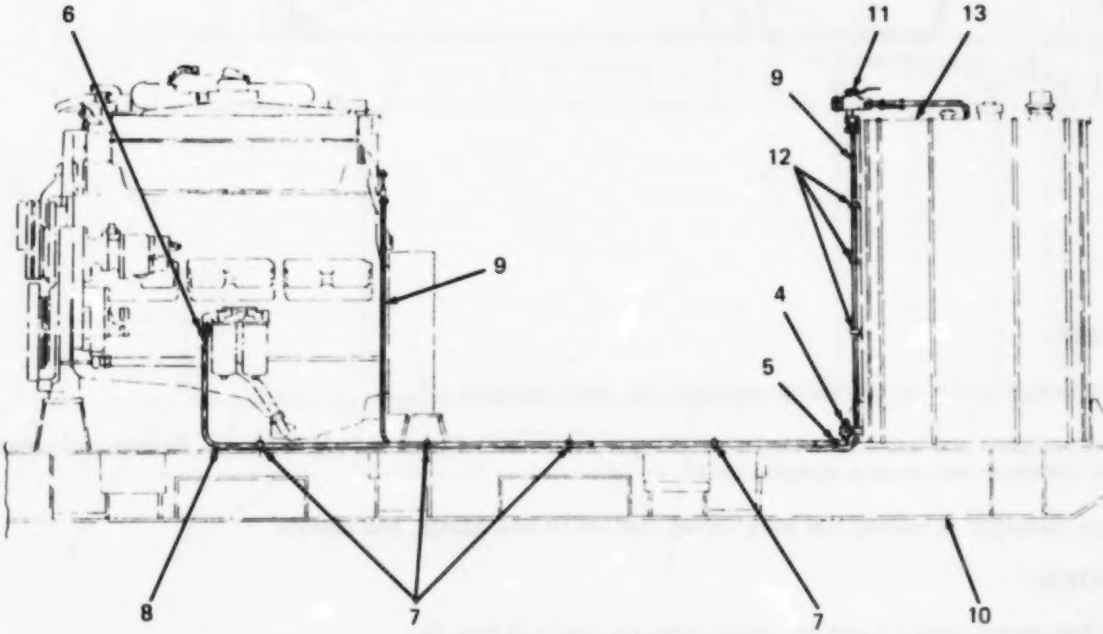
8 Unscrew fitting (5) off fuel supply valve (4) and catch fuel in suitable container.

9 Unscrew fitting (6) and catch remaining fuel in container.

10 Loosen clamp (7) securing fuel supply line (8) and return line (9) to skid (10) and remove fuel supply line.

11 Turn fuel return valve (11) to OFF position.

12 Loosen clamp (12) securing fuel return line (9) to fuel tank (13).

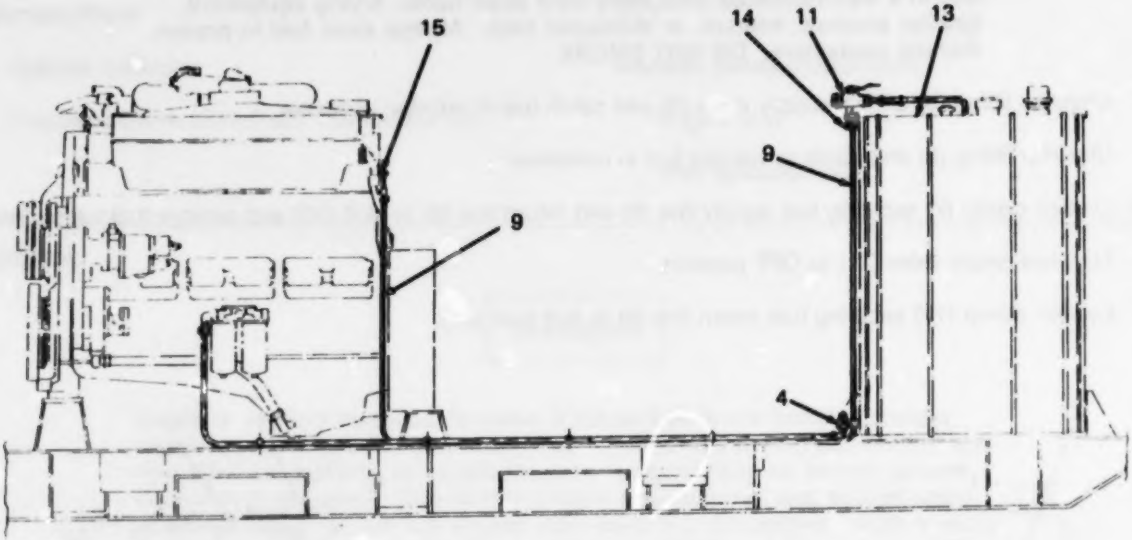


2-21. FEEDING SYSTEM REPAIR/REPLACE (CONT)

13 Unscrew fitting (14) securing fuel return line (9) to fuel tank (13).

14 Unscrew fitting (15) securing fuel return line (9) to return system and remove return line.

15 Unscrew fuel supply valve (4) and fuel return valve (11) from fuel tank (13).



INSPECTION:

1 Inspect fittings and hose clamps for damage, rust, and corrosion.

2 Inspect fuel lines and fuel return line for cracking or brittleness. Check lines for leakage. Remove only minor rust or corrosion with crocus abrasive cloth.

3 Replace damaged or leaking fuel lines, valves, fuel return line, fittings, and clamps.

INSTALLATION:

1 Install fuel supply valve (1) and fuel return valve (2) onto fuel tank (3).

2 Position fuel return line (4) to return system and connect fitting (5).

2-21. FEEDING SYSTEM REPAIR/REPLACE (CONT)

3 Connect fitting(6) from fuel return line (4) to fuel tank (3).

4 Connect clamps (7) to fuel return line (4) and tighten.

5 Connect fuel supply line (8) and return line (4) to clamps (9).

6 Connect fitting (10) on fuel supply valve (1).

7 Connect fitting (11).

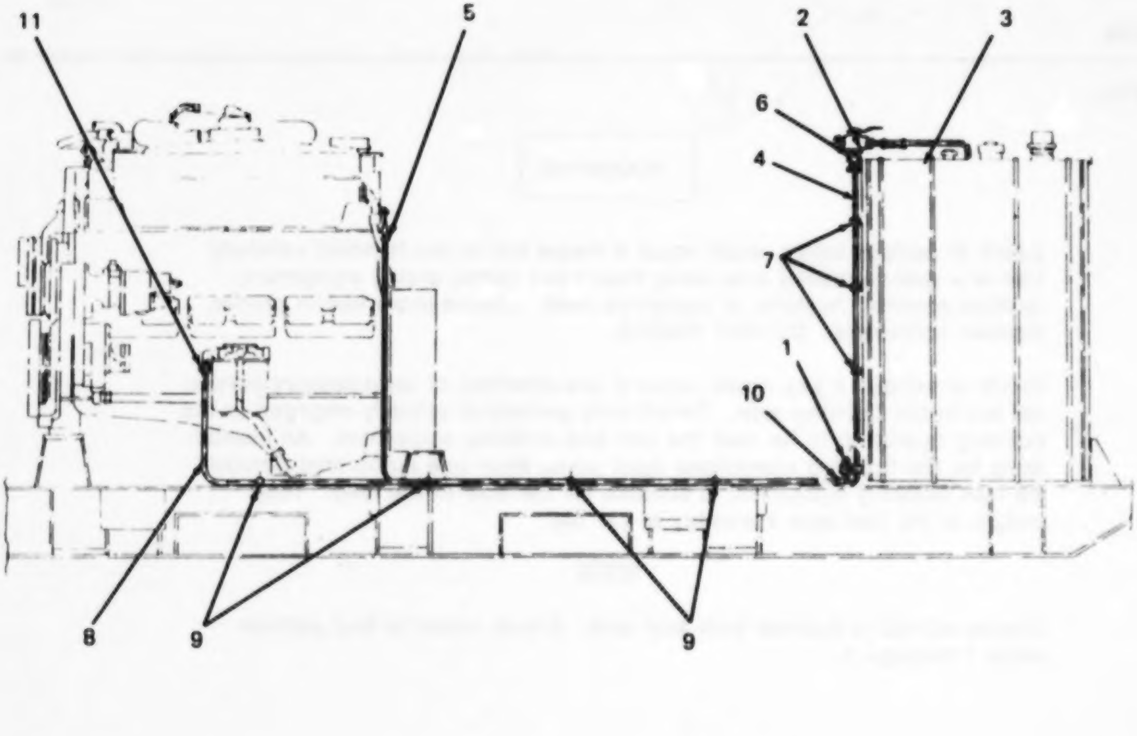
8 Install battery box.

9 Fill fuel tank.

BLEEDING FUEL SYSTEM:

1 Open supply valve (1) and return valve (2).

2 Crack fuel supply line fitting (11) at fuel filter until fuel flows out and tighten fitting.



2-22. TANK ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable hoist and sling

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Adhesive sealant (Item 3, Appendix B)

Crocus abrasive cloth (Item 1, Appendix C)

Suitable container

Blocks

Personnel Required

Two

Equipment Condition Reference	Condition Description
Paragraph 2-21	Feeding system removed

General Safety Instructions

Well ventilated area

REMOVAL:

WARNING

Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person. Be sure hoisting equipment is suitable for the size of the load. Total weight of the fuel tank assembly is 231 lbs.

NOTE

Ensure all fuel is drained from fuel tank. If tank contains fuel perform steps 1 through 5.

2-22. TANK ASSEMBLY REPAIR/REPLACE (CONT)

1 Loosen cap (1) on fuel tank (2).

2 Remove drain plug (3).

3 Drain fuel into a suitable container. Tank capacity is 110 gallons.

4 Install drain plug (3).

5 Tighten cap (1).

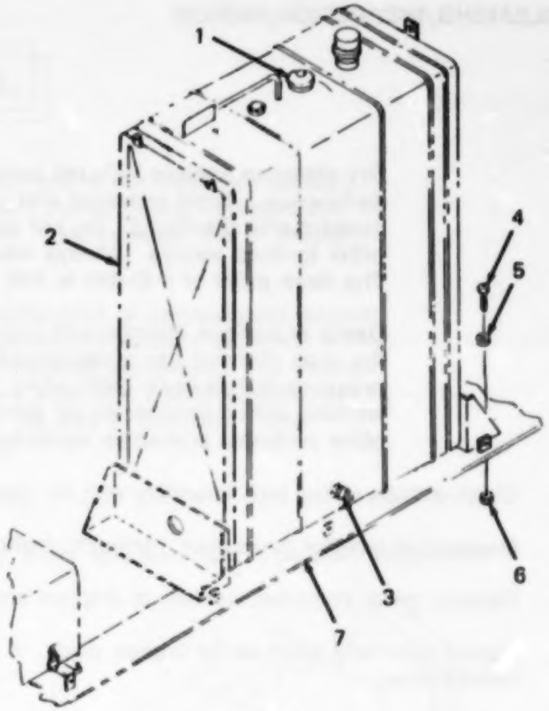
6 Remove four screws (4), washers (5), nuts (6) securing fuel tank (2) to skid assembly (7).

7 Position a suitable lifting device over the fuel tank assembly (2).

8 Attach slings around assembly and put tension on slings. Make sure assembly is properly supported.

9 Lift and remove tank assembly (2) from skid assembly (7).

10 Lower onto blocks on a stable, level work platform.



2-22. TANK ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean outside of fuel tank assembly with dry cleaning solvent. Dry with compressed air.

2 Inspect fuel tank for dents, rust, corrosion, leaks, or other damage.

3 Remove minor corroded, dented, or chipped areas using crocus abrasive cloth. Clean and refinish surfaces.

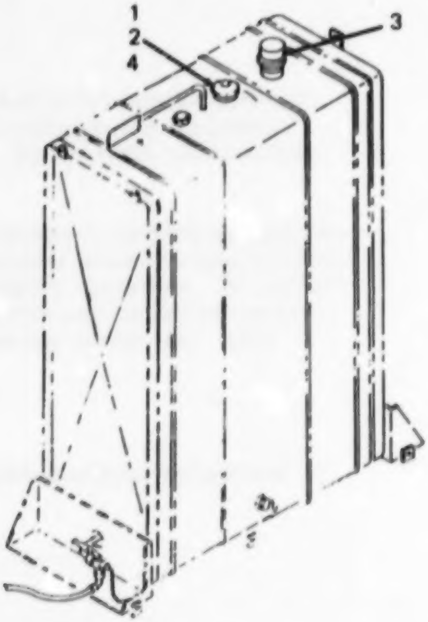
4 Inspect mounting brackets for broken welds. If any welds are found cracked, notify direct support maintenance.

5 Remove fuel tank cap (1) and check that gasket (2) is present and in good condition. Replace as necessary.

6 Inspect fuel level gauge (3) for damage.

7 Inspect fuel tank cap vent valve (4) is open and free from any debris.

8 If further maintenance is required, notify direct support maintenance.



2-22. TANK ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:

WARNING

Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person. Be sure hoisting equipment is suitable for the size of the load. Total weight of the fuel tank assembly is 231 lbs.

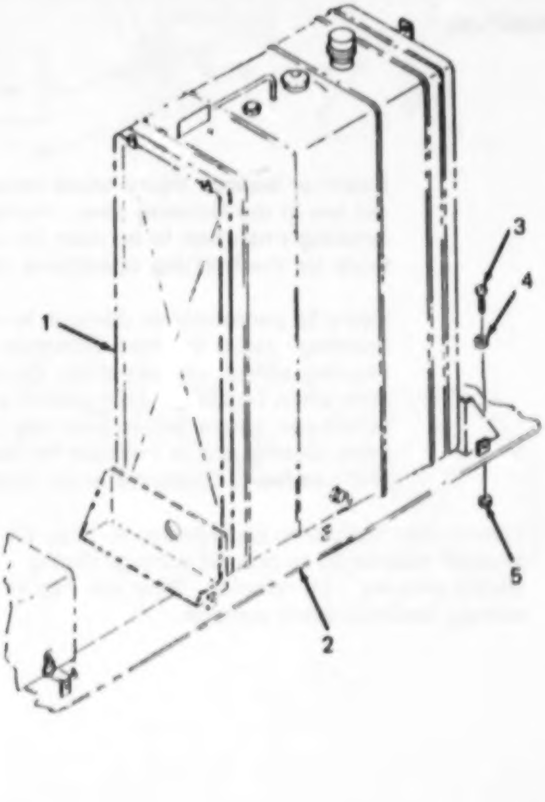
1 Position a suitable lifting device over the fuel tank assembly.

2 Attach slings around assembly and put tension on slings. Make sure assembly is properly supported.

3 Lift and remove tank assembly (1) from blocks on the work platform and position on skid assembly (2).

4 Apply adhesive sealant to four screws (3) and install screws (3), washers (4), and nuts (5) and secure fuel tank (1) to skid assembly (2).

5 Install feeding system in accordance with paragraph 2-21.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable hoist and sling

Materials/Parts

Dry cleaning solvent (Item 25, Appendix C)

Soft cloth

Crocus abrasive cloth (Item 1, Appendix C)

Blocks

Personnel Required

Two

Equipment Condition Reference	Condition Description
Paragraph 2-18	Engine exhaust system removed

General Safety Instructions

Well ventilated area

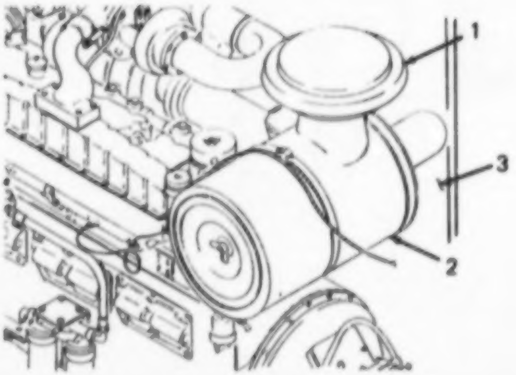
REMOVAL:

WARNING

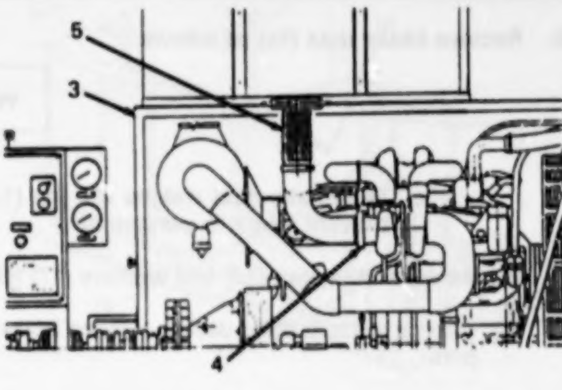
Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Loosen rain cap clamp and remove rain cap (1) from air cleaner (2) to prevent damage during engine enclosure (3) removal. Stow rain cap in storage box to prevent damage.



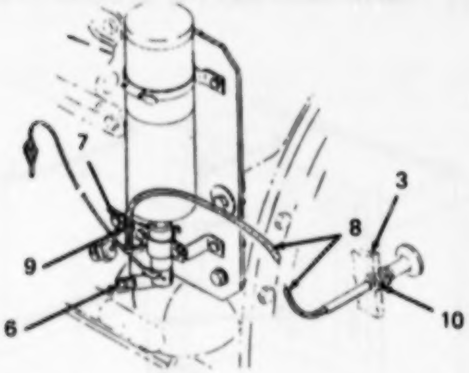
2 Loosen clamp (4) and remove exhaust piping (5) from engine enclosure (3).



3 Loosen screw (6) and (7). Remove cold starting aid control cable and knob (8) from clamp (9).

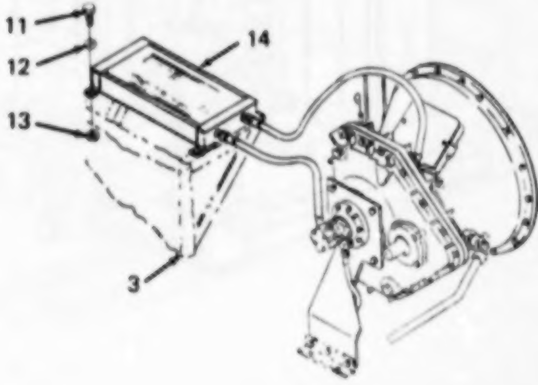
4 Loosen and remove nut (10).

5 Remove cold starting aid control cable and knob (8) from engine enclosure (3).



6 Remove five bolts (11), washers (12), and nuts (13) from speed increaser heat exchanger (14) and mounting bracket.

7 Remove heat exchanger (14) from engine enclosure (3).



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

8 Remove intake duct (15) as follows:

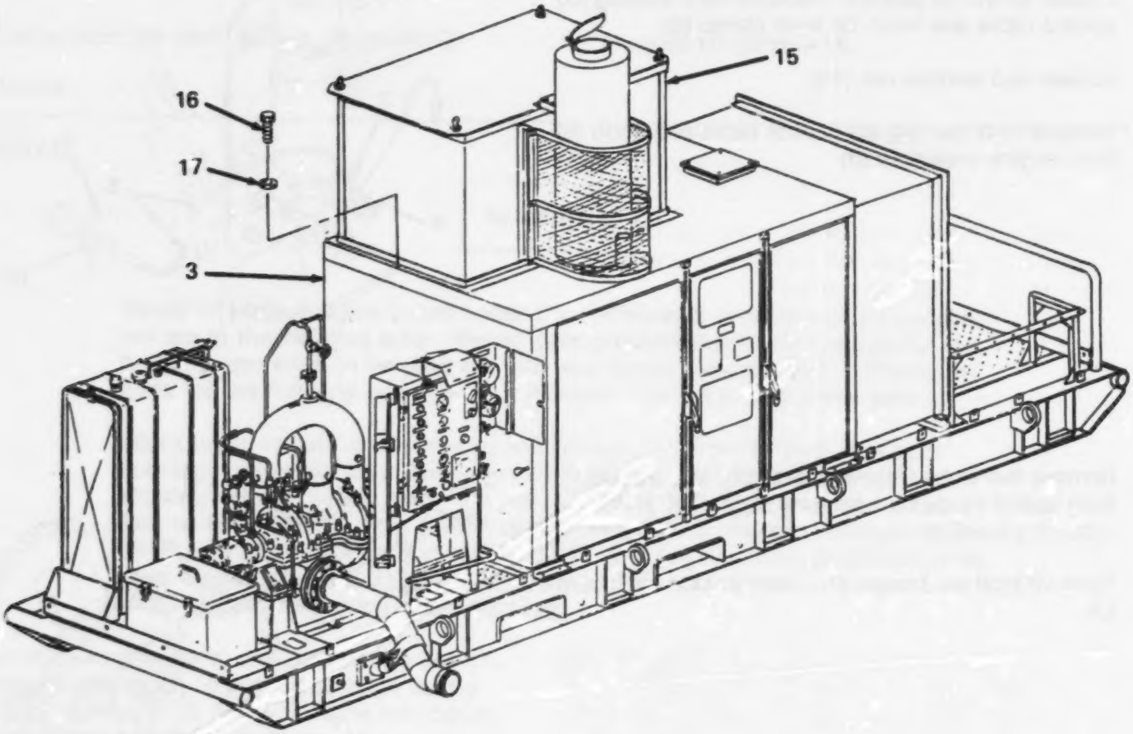
WARNING

The intake duct weighs 275 lbs (124 kg). Use a suitable lifting device to prevent injury to personnel.

(a) Remove 24 screws (16) and washers (17) from intake duct (15).

(b) Using a suitable lifting device, remove intake duct (15) from top of engine enclosure (3) and air intake port.

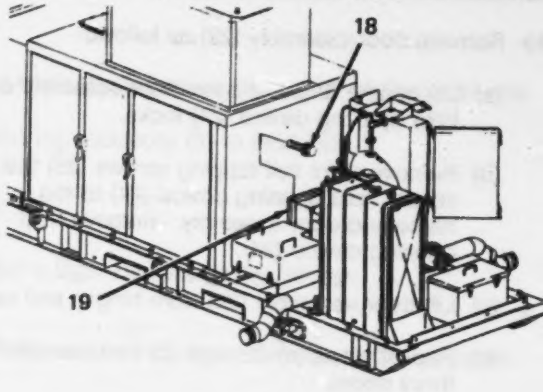
(c) Position intake duct (15) on blocks on a stable, level work platform.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

9 Remove four screws and washers (18) from coupling guard (19).

10 Remove coupling guard (19) from engine enclosure (3).

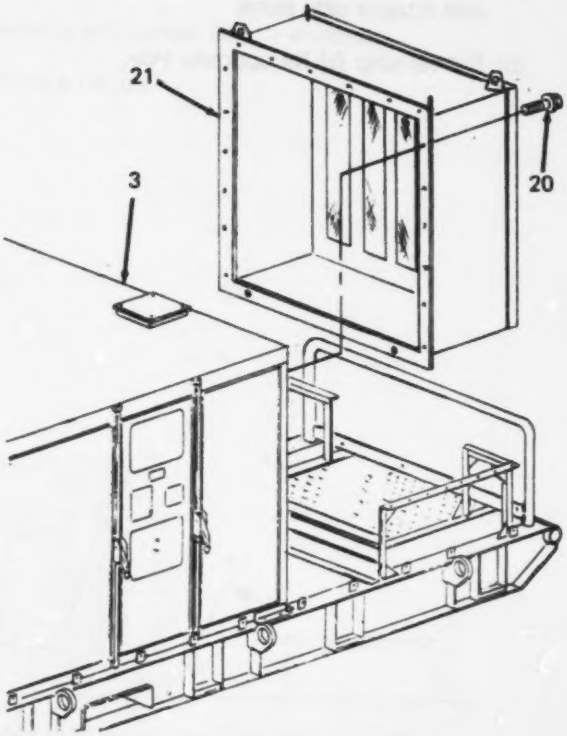


11 Remove 23 screws and washers (20) from outlet duct (21).

WARNING

The outlet duct weighs 286 lbs (195 kg). Use a suitable lifting device to prevent injury to personnel.

12 Remove outlet duct (21) from engine enclosure (3) using suitable lifting device.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

13 Remove door assembly (22) as follows:

(a) Lift handle (23) and open door assembly until hold opening device (24) locks.

(b) Remove eight self tapping screws (25) that secure hold opening device (24) to the frame and door assembly. Remove hold opening device (24).

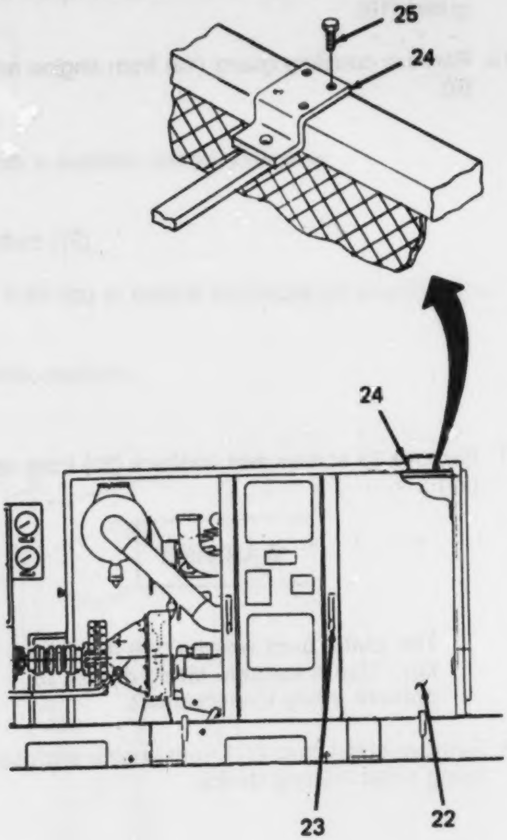
(c) Lift door assembly (22) from hinges and remove.

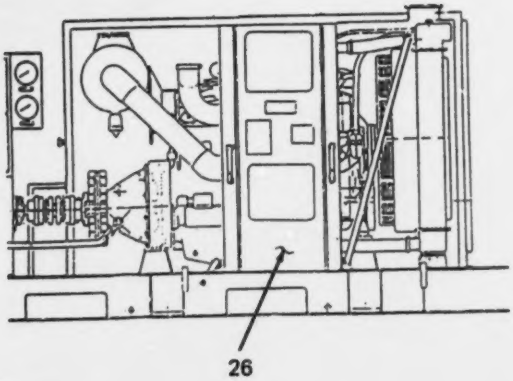
(d) Repeat steps (a) through (c) from remaining three doors.

14 Remove side panel assembly (26) as follows:

(a) From inside engine enclosure (3), rotate handles and remove side panel.

(b) Repeat step (a) for opposite side.





2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

15 Remove enclosure (3) from skid assembly (29) as follows:

(a) Secure sling to four eyebolts on enclosure (3). Secure hoist to sling above the center of the enclosure.

(b) Remove 12 screws and washers (27) and nuts (28) securing enclosure (3) to skid (29).

WARNING

The enclosure with doors weighs 1258 lbs (570 kg). Use a suitable lifting device to prevent injury to personnel.

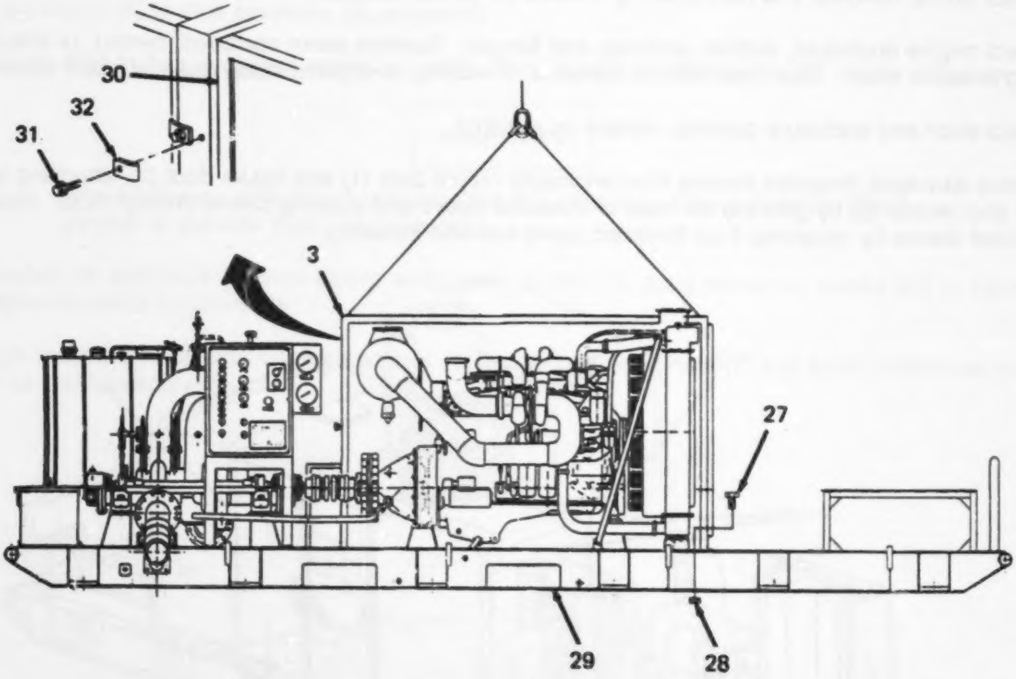
(c) Carefully lift enclosure (3) from skid (29) making sure it does not catch on or damage engine or pump component.

(d) Place removed enclosure on blocks, leveled to prevent distortion of the frame.

16 Remove end panels (30) as follows:

(a) Remove five bolts, washers (31), and clamps (32) securing end panels (30) to enclosure.

(b) Swing end panels open and lift end panels from enclosure hinges.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Remove all oily dirt, grease, and diesel fuel oil from engine enclosure components with rags moistened with dry cleaning solvent.

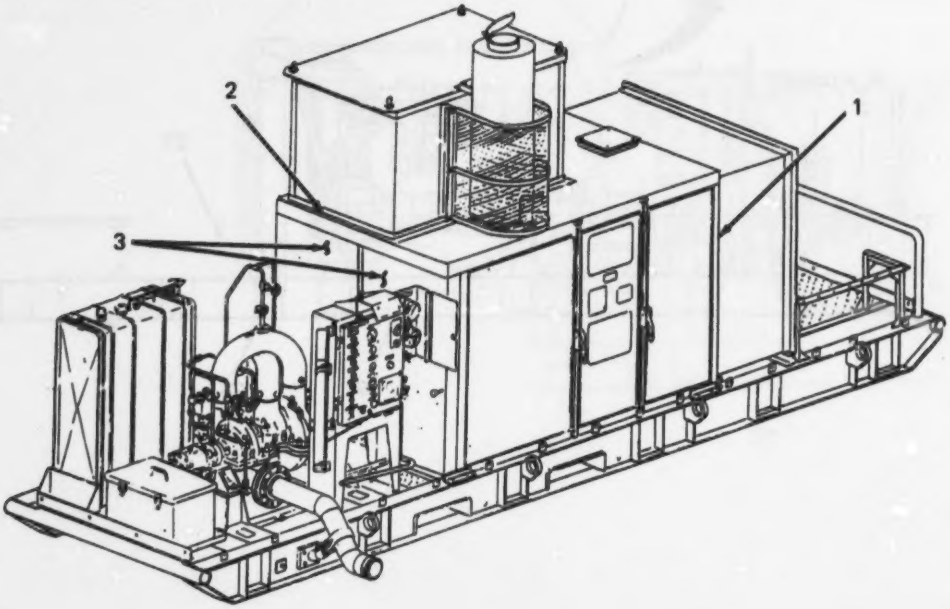
2 Dry all parts with compressed air.

3 Inspect doors, handles, and hold opening devices for proper operation.

4 Inspect engine enclosure, outside surfaces, and flanges. Remove minor corroded, dented, or chipped areas using abrasive cloth. Clean and refinish surfaces. If welding is required notify direct support maintenance.

5 Inspect door and enclosure gaskets, replace as required.

6 Remove damaged threaded sleeves from enclosure output duct (1) and intake duct (2), attaching areas, and from end panels (3) by grinding off head of threaded sleeve and pushing sleeve through hole. Insert new threaded sleeve by mounting it on threaded insert tool and installing.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

INSTALLATION:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Install end panels (1) as follows:

(a) Position end panels (1) on enclosure hinges and close panels.

(b) Secure end panels (1) to enclosure using five clamps (2), washers, and bolts (3).

2 Install enclosure (4) to skid assembly (5) as follows:

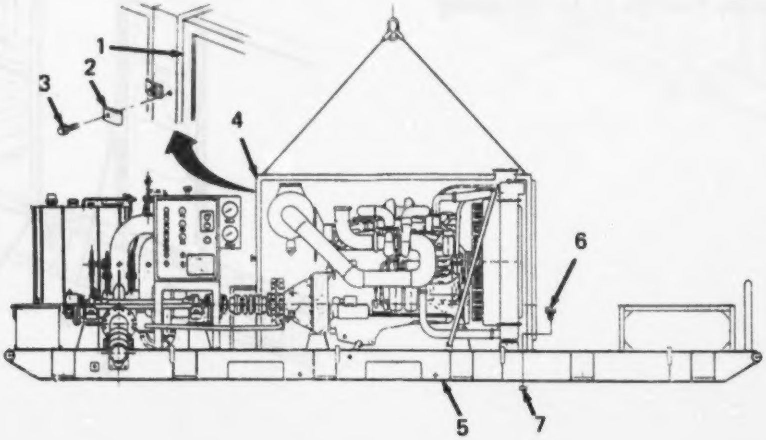
(a) Secure sling to four eyebolts on enclosure (4). Secure hoist to sling above the center of the enclosure.

WARNING

The enclosure with doors weighs 1258 lbs (570 kg). Use a suitable lifting device to prevent injury to personnel.

(b) Carefully lift enclosure (4) from blocks and locate on skid (5) being extremely careful not to damage engine or pump components.

(c) Align mounting holes and insert 12 screws and washers (6) and nuts (7) and fasten enclosure assembl (4) to skid assembly (5).



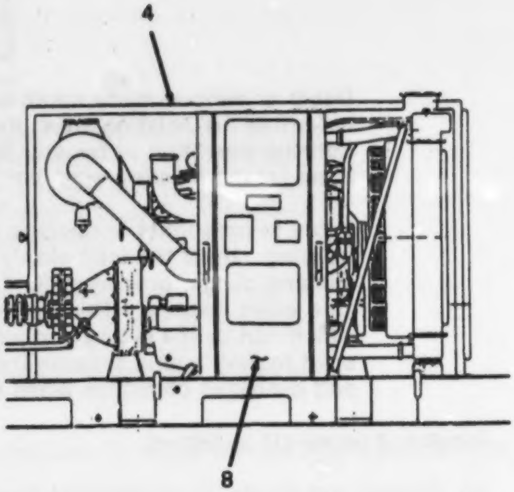
2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

3 Install side panel assembly (8) as follows:

(a) Position side panel (8) in place.

(b) From inside engine enclosure (4), rotate handles and secure side panel (8) in place.

(c) Repeat steps (a) and (b) for opposite side.



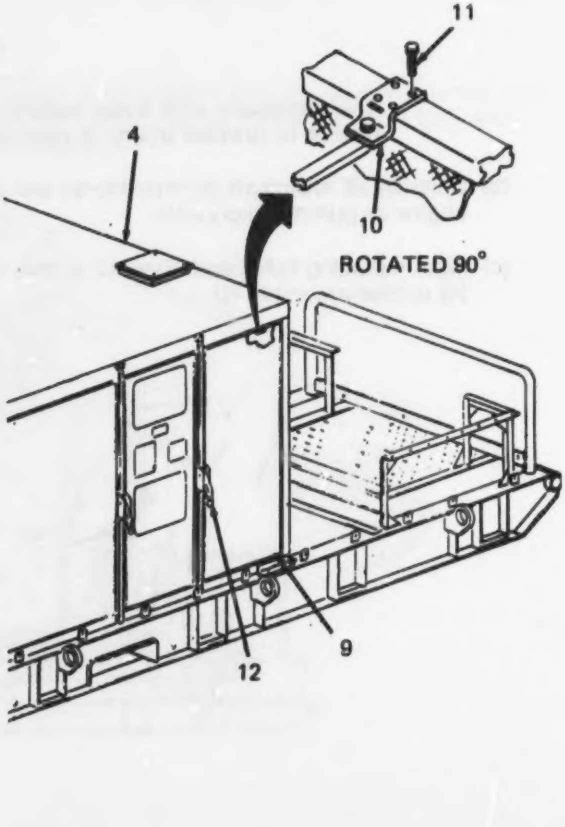
4 Install door assembly (9) as follows:

(a) Lift door assembly (9) and position on hinges.

(b) Position hold opening device (10) in place. Install eight self tapping screws (11) that secure hold opening device (10) to engine enclosure (4) and door assembly (9).

(c) Push handle assembly (12) down and secure door in place.

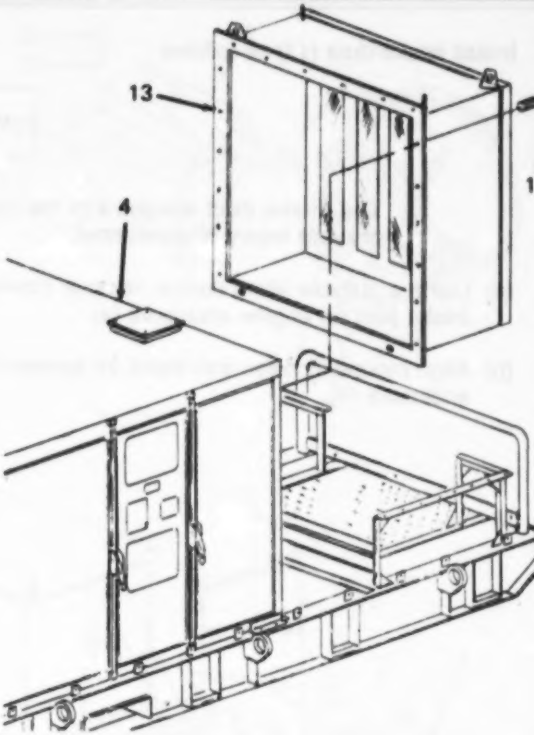
(d) Repeat steps (a) through (c) for remaining doors.



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

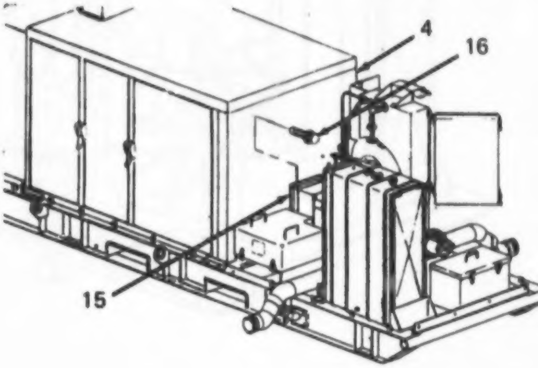
WARNING

The outlet duct weighs 386 lbs (195 kg). Use a suitable lifting device to prevent injury to personnel.



5 Position outlet duct (13) against engine enclosure (4) and align mounting holes.

6 Install 23 screws and washers (14) and secure outlet duct (13) to engine enclosure (4).



7 Position coupling guard (15) against engine enclosure (4) and align mounting holes.

8 Install four screws and washers (16) and secure coupling guard (15) to engine enclosure (4).

2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

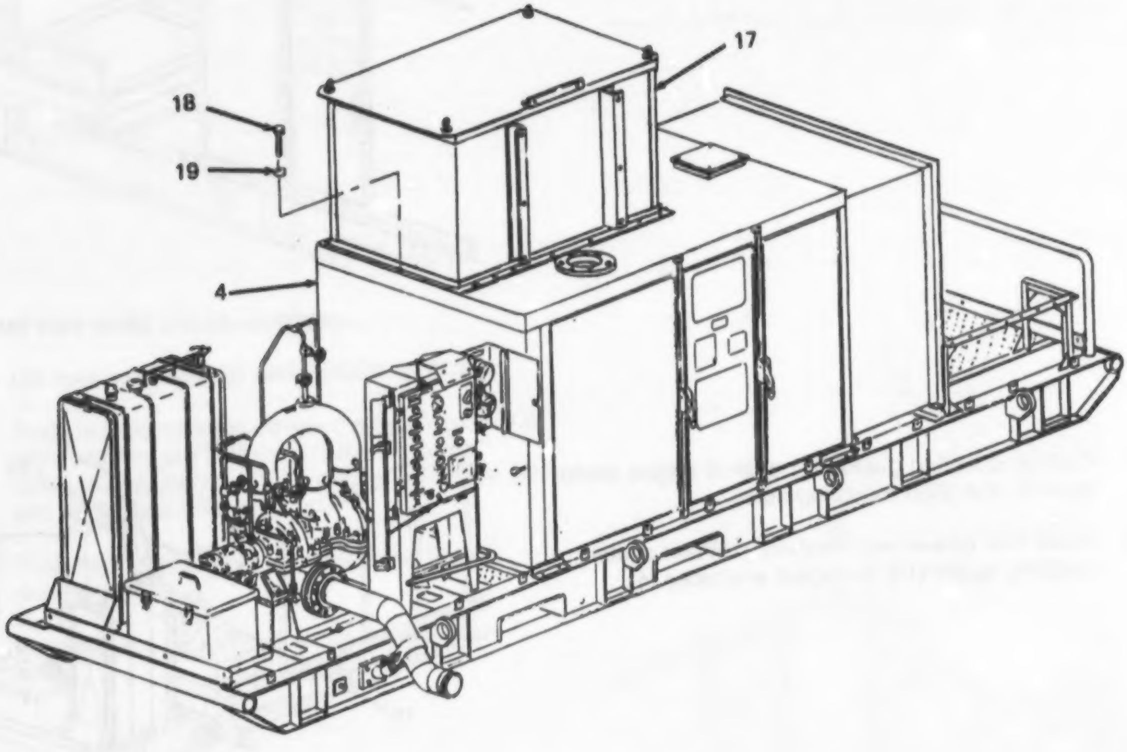
9 Install intake duct (17) as follows:

WARNING

The intake duct weighs 275 lbs (124 kg). Use a suitable lifting device to prevent injury to personnel.

(a) Using a suitable lifting device, remove intake duct (17) from work platform and position on top of air intake port on engine enclosure (4).

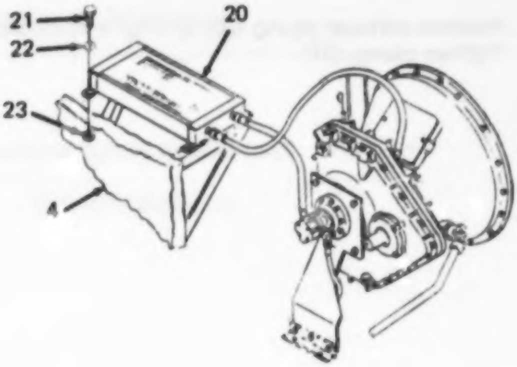
(b) Align mounting holes and install 24 screws (18) and washers (19). Secure intake duct (17) to engine enclosure (4).



2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

10 Position heat exchanger (20) on engine enclosure (4).

11 Install five bolts (21), washers (22), and nuts (23) and secure heat exchanger and mounting bracket (20) to engine enclosure (4).



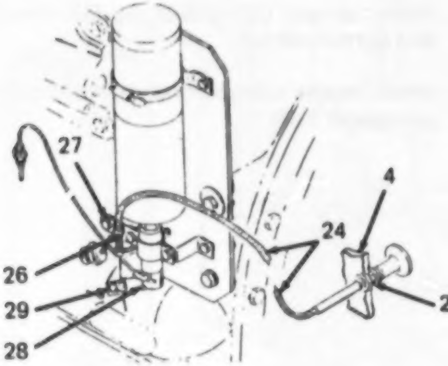
12 Install cold starting aid and knob and cable assembly (24) through engine enclosure (4).

13 Slide backup nut (25) onto cable assembly (24) and fasten to engine enclosure (4).

14 Insert cable assembly (24) into clamp (26) and tighten two bolts (27).

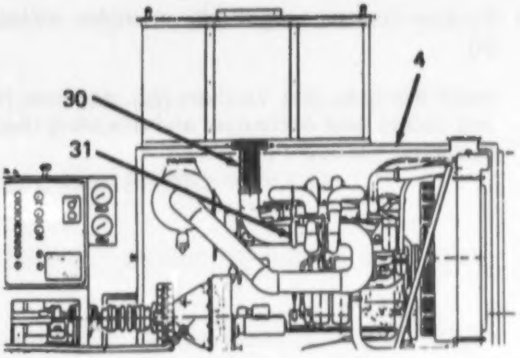
15 Install cable to valve (28) and tighten screw (29).

16 Final cable adjustment may be necessary.



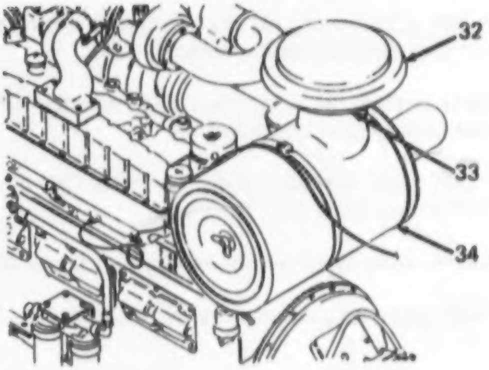
2-23. ENGINE ENCLOSURE REPAIR/REPLACE (CONT)

17 Position exhaust piping (30) to engine enclosure (4). Tighten clamp (31).



18 Place rain cap (32) and clamp (33) on air cleaner (34) and tighten clamp.

19 Install engine exhaust system in accordance with paragraph 2-18.



2-24. STORAGE BOX AND COVER REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

General Safety Instructions

Well ventilated area

REMOVAL:

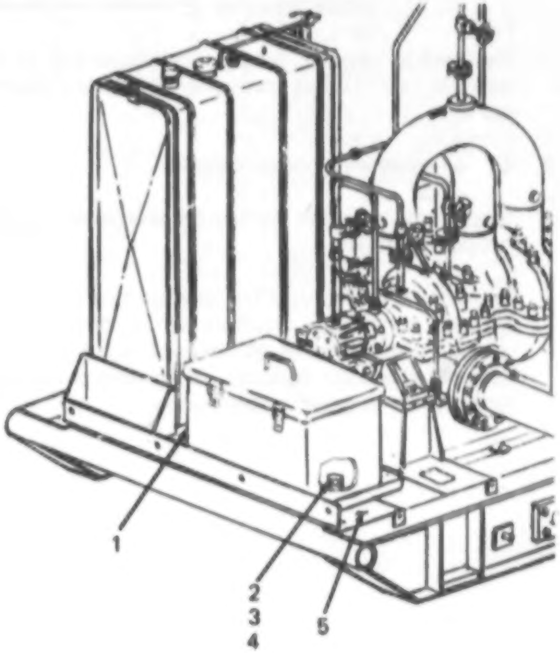
1 Remove contents of storage box (1).

2 Remove four mounting screws (2), washers (3), and nuts (4).

NOTE

Storage box and cover empty weighs approximately 59 lbs (27 kg).

3 Remove storage box and cover (1) from skid assembly (5).



2-24. STORAGE BOX AND COVER REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

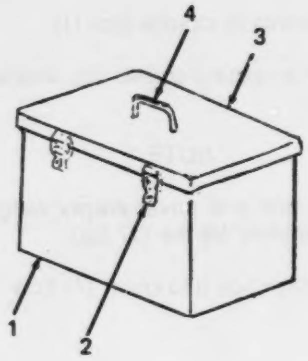
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Remove all oily dirt, grease, and diesel fuel oil from storage box (1) and components with dry cleaning solvent.

2 Dry all parts with compressed air.

3 Inspect storage box latches (2) and cover (3) for proper operation.

4 Inspect the surfaces of the storage box (1), cover (3), and handle (4). Remove minor corroded, dented, or chipped areas using abrasive cloth. Clean and refinish surfaces. If welding is required, notify direct support maintenance.



2-24. STORAGE BOX AND COVER REPAIR/REPLACE (CONT)

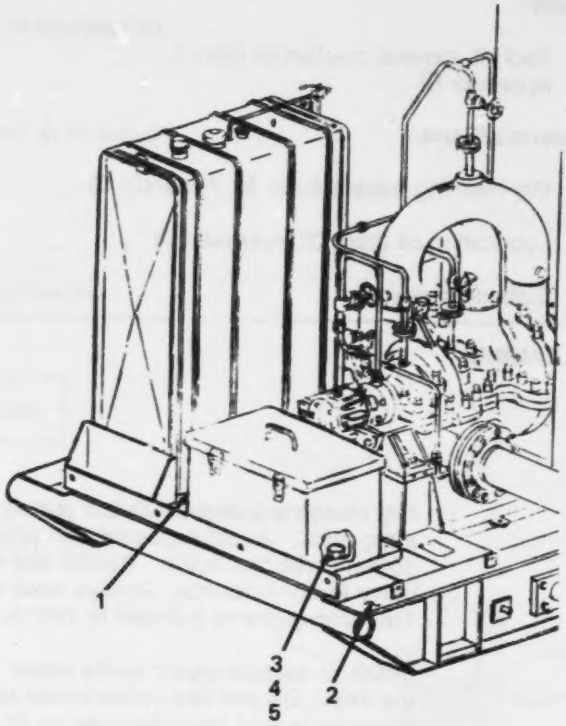
INSTALLATION:

NOTE

Storage box and cover empty weighs approximately 59 lbs (27 kg).

1 Position storage box (1) over mounting holes on skid assembly (2).

2 Install four mounting screws (3), washers (4), and four nuts (5) and secure to skid assembly.



3 Install contents of storage box.

4 Close storage box cover and insure catches are securely fastened.

2-25. PUMP ASSEMBLY SERVICE

This task covers: a. Cleaning b. Servicing

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Lubricating oil (Item 22, Appendix C)

Suitable container

General Safety Instructions

Well ventilated area

CLEANING:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing or vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Remove all oily dirt, grease, and diesel fuel from areas surrounding pump assembly drain plug (1), oil fill cap (2), and sight glass (3) with dry cleaning solvent.

2 Dry all parts with compressed air.

2-25. PUMP ASSEMBLY SERVICE (CONT)

SERVICING:

NOTE

Drain oil while warm.

Fill with clean lubricating oil.

1 Drain oil as follows:

(a) Place a drain pan under oil drain plug (1). Loosen oil fill cap (2).

(b) Remove drain plug and drain oil.

(c) Replace drain plug and tighten.

(d) Repeat steps (a) through (c) on opposite bearing housing.

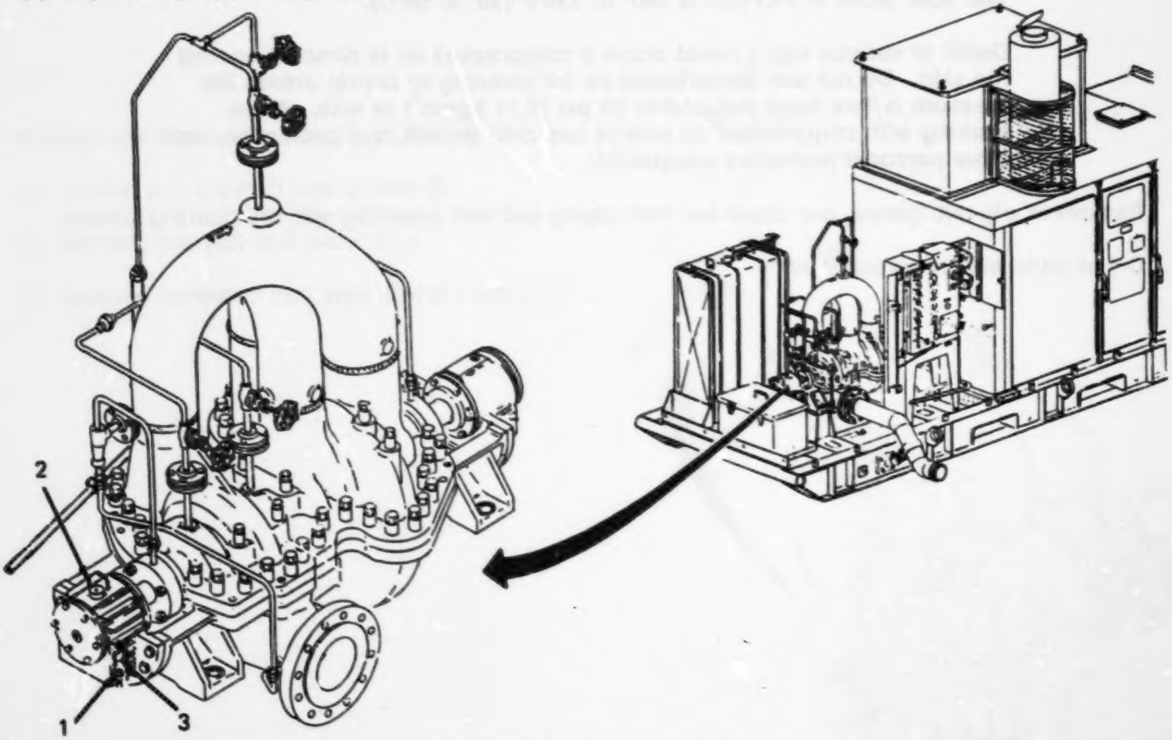
2 Fill oil as follows:

(a) Remove oil fill cap (2).

(b) Fill until oil sight glass (3) shows oil sump is full.

(c) Replace oil fill cap.

(d) Repeat steps (a) through (c) on opposite bearing housing.



-26. PIPING AND VENT ASSEMBLY REPLACE

his task covers: a. Cleaning b. Removal c. Installation d. Operational Check

NITIAL SETUP

ools

Tool kit, general mechanics (item 1, Appendix B)

laterials/Parts

Dry cleaning solvent (item 30, Appendix C)

Gaskets

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area

CLEANING:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

Remove all oily dirt, grease, and diesel fuel from piping and vent assembly with dry cleaning solvent.

Dry all parts with compressed air.

2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

REMOVAL:

WARNING

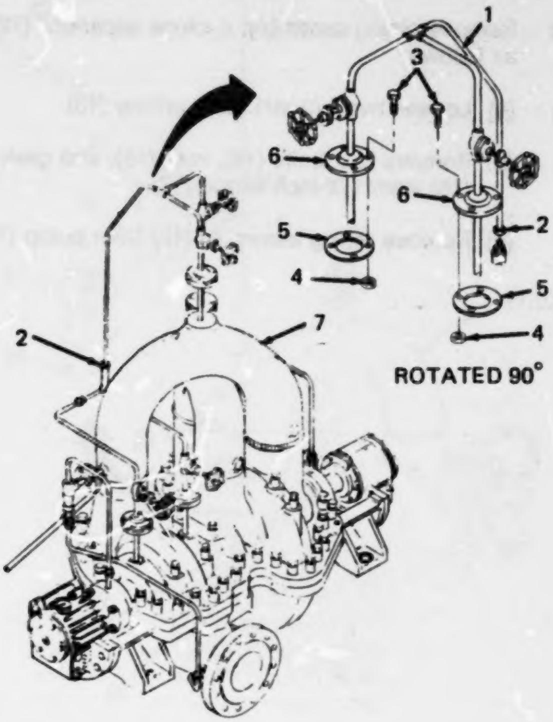
Ensure there is no pressure existing on pump assembly and all fluid is properly drained before attempting to replace the piping and vent assembly.

1 Remove crossover vent valve assembly (1) as follows:

(a) Loosen 1/2-inch pipe union (2).

(b) Remove eight bolts (3), nuts (4), and two gaskets (5) from the two 1/2-inch flanges (6).

(c) Remove crossover vent assembly (1) from pump (7).

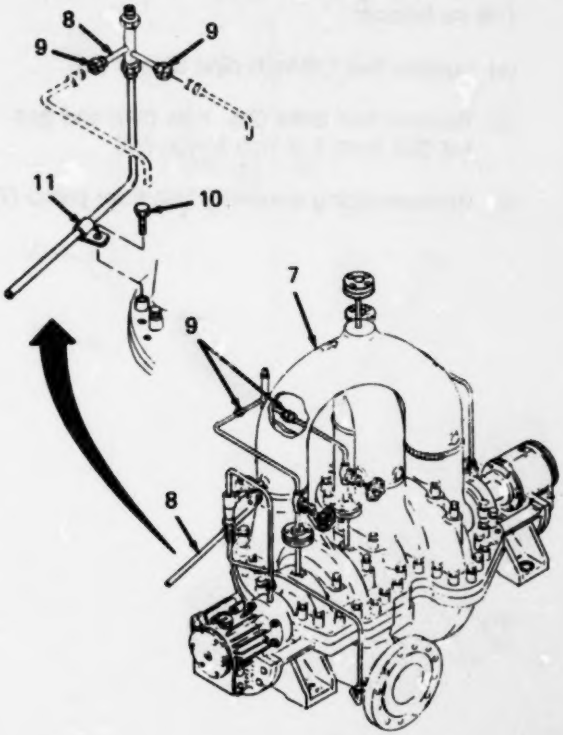


2 Remove combined vent pipe (8) as follows:

(a) Loosen two 1/2-inch pipe unions (9).

(b) Remove bolt (10) and clamp (11).

(c) Remove combined vent pipe (8) from pump (7).



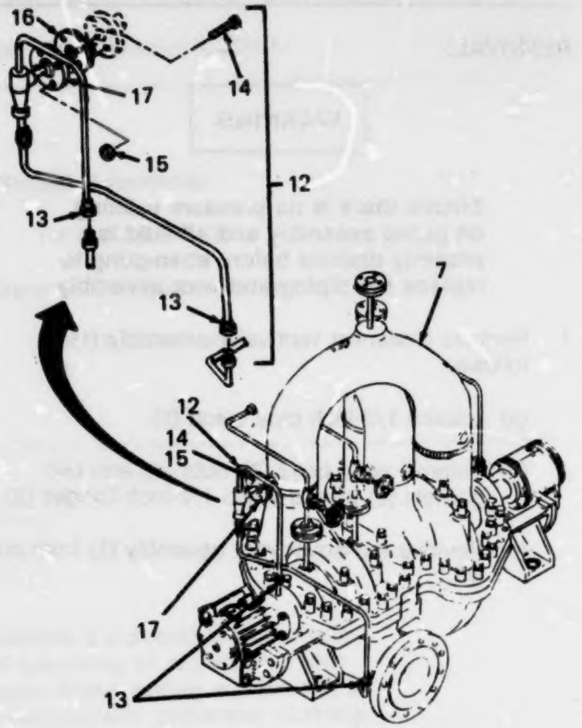
2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

3 Remove piping assembly, cyclone separator (12) as follows:

(a) Loosen two 1/2-inch pipe unions (13).

(b) Remove four bolts (14), nuts (15), and gasket (16) from 1/2-inch flange (17).

(c) Remove piping assembly (12) from pump (7).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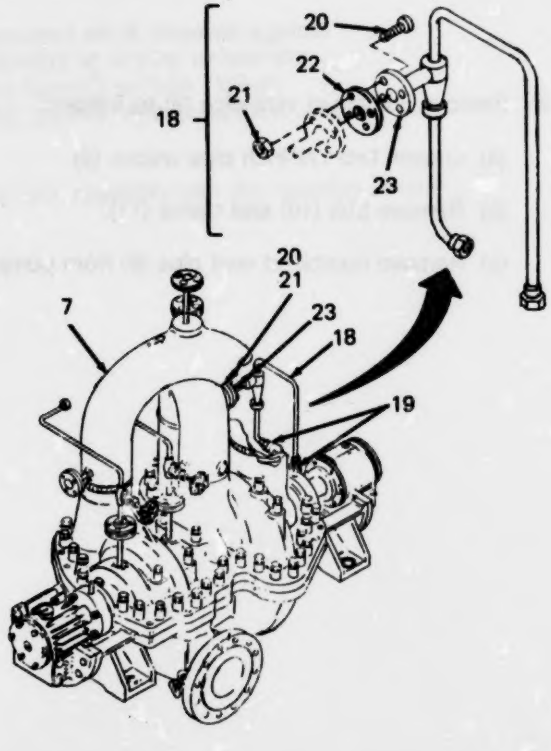
4 Remove piping assembly cyclone separator (18) as follows:

(a) Loosen two 1/2-inch pipe unions (19).

(b) Remove four bolts (20), nuts (21), and gasket (22) from 1/2-inch flange (23).

(c) Remove piping assembly (18) from pump (7).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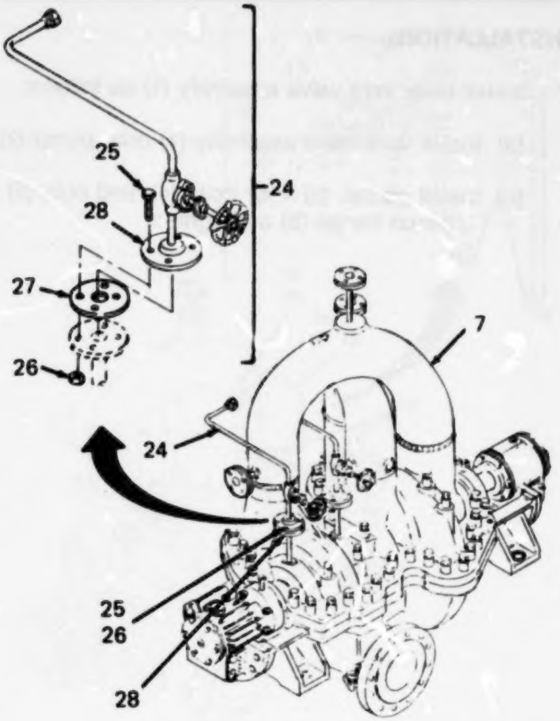
2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

5 Remove vent valve assembly (outer) (24) as follows:

(a) Remove four bolts (25), nuts (26), and gaskets (27) from 1/2-inch flange (28).

(b) Remove vent valve assembly (24) from pump (7).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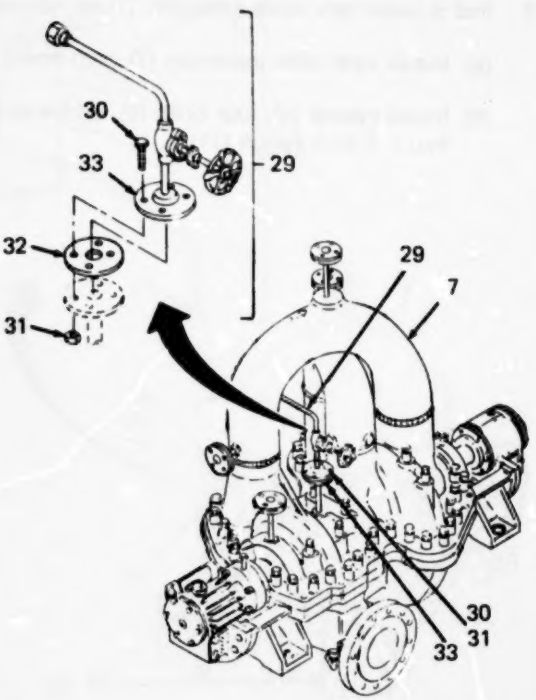
6 Remove vent valve assembly (inner) (29) as follows:

(a) Remove four bolts (30), nuts (31), and gaskets (32) from 1/2-inch flange (33).

(b) Remove vent valve assembly (29) from pump (7).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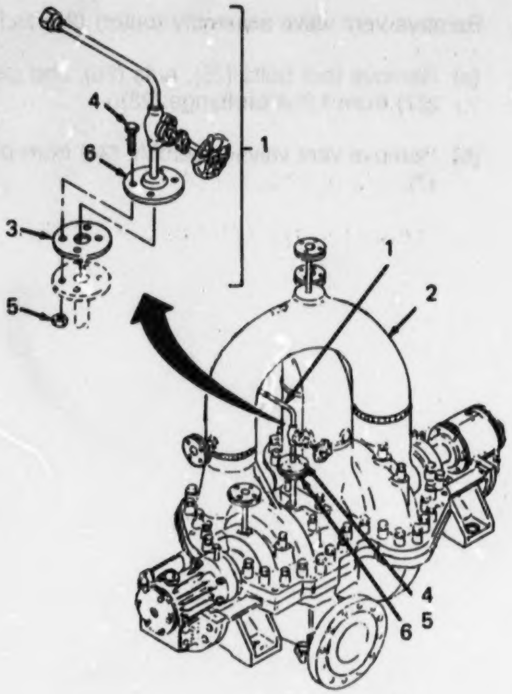
2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

INSTALLATION:

1 Install inner vent valve assembly (1) as follows:

(a) Install vent valve assembly (1) onto pump (2).

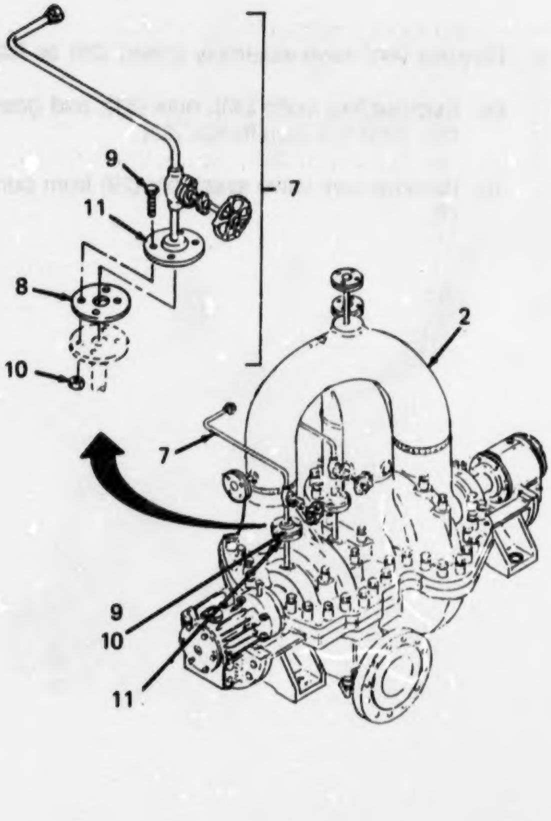
(b) Install gasket (3), four bolts (4), and nuts (5) into 1/2-inch flange (6) and tighten.



2 Install outer vent valve assembly (7) as follows:

(a) Install vent valve assembly (7) onto pump (2).

(b) Install gasket (8), four bolts (9), and nuts (10) into 1/2-inch flange (11).



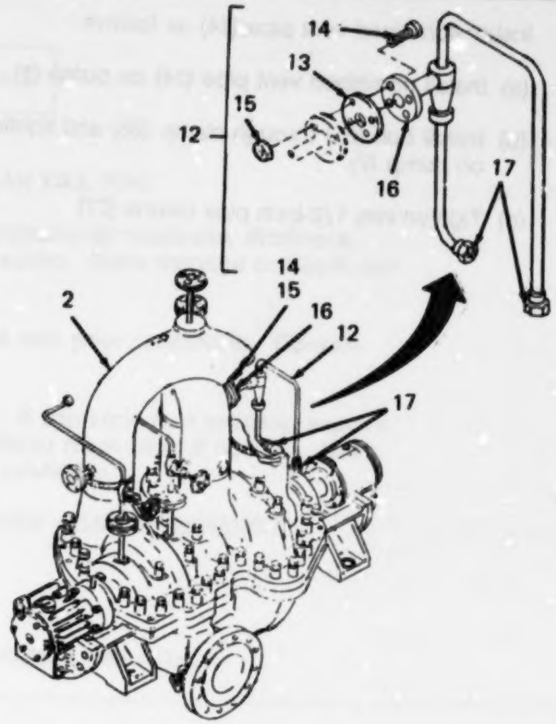
2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

3 Install piping assembly cyclone separator (12) as follows:

(a) Install piping assembly (12) onto pump (2).

(b) Install gasket (13), four bolts (14), and nuts (15) into 1/2-inch flange (16).

(c) Tighten two 1/2-inch pipe unions (17).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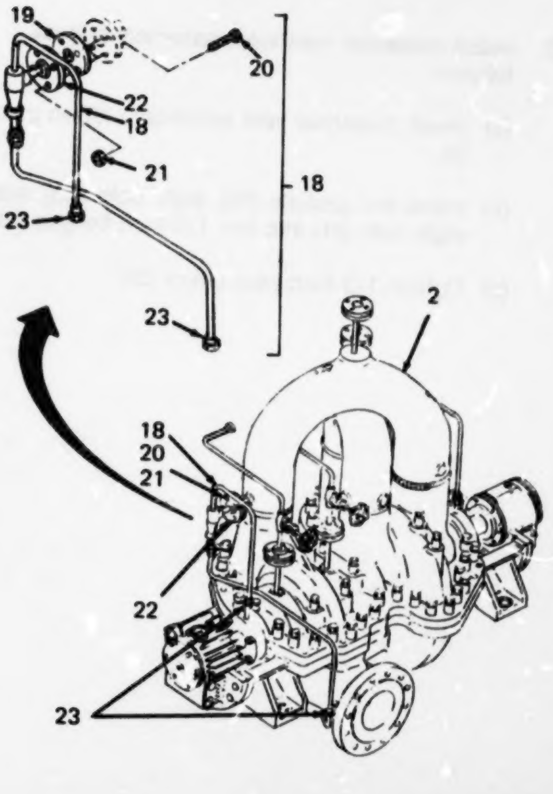
4 Install piping assembly cyclone separator (opposite coupling end) (18) as follows:

(a) Install piping assembly (18) onto pump (2).

(b) Install gasket (19), four bolts (20), and nuts (21) into 1/2-inch flange (22).

(c) Tighten two 1/2-inch pipe unions (23).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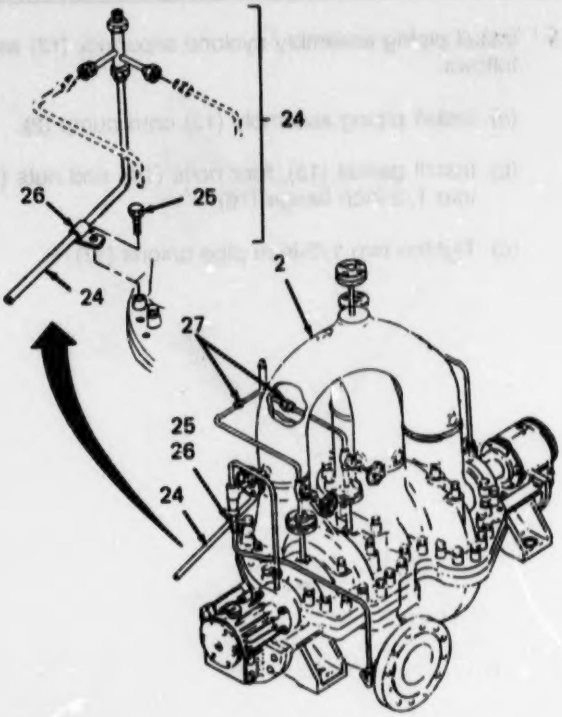
2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

5 Install combined vent pipe (24) as follows:

(a) Install combined vent pipe (24) on pump (2).

(b) Install bolt (25) through clamp (26) and tighten on pump (2).

(c) Tighten two 1/2-inch pipe unions (27).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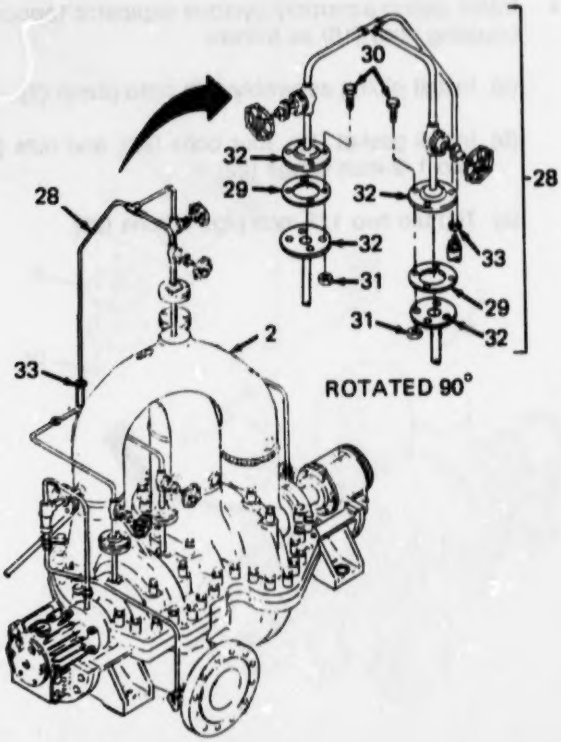
6 Install crossover vent valve assembly (28) as follows:

(a) Install crossover vent assembly (28) on pump (2).

(b) Install two gaskets (29), eight bolts (30), and eight nuts (31) into two 1/2-inch flanges (32).

(c) Tighten 1/2-inch pipe union (33).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2-26. PIPING AND VENT ASSEMBLY REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Observe newly installed components for leaks or other obvious malfunctions.

2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE

This task covers: a. Servicing b. Testing c. Removal d. Installation

INITIAL SETUP

Test Equipment

Battery hydrometer (Item 2, Appendix B)

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Battery terminal puller (Item 2, Appendix B)

Materials/Parts

Baking soda (Item 7, Appendix C)

Battery brush

Grease (Item 14, Appendix C)

Wire brush

Lockwashers

Materials/Parts (cont)

Suitable tags

Gaskets

Distilled water

Cloth

Manual References

TM 9-6140-200-14

Condition Description

Engine shut down and cool

General Safety Instructions

Area must be well ventilated. Smoking, open flame, or spark producing tools are prohibited.

SERVICING:

WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

CAUSTIC CHEMICALS IN BATTERIES

Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

Avoid making contact across the two battery posts. This can result in severe arcing, which could cause an explosion resulting in bodily injury.

2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

1 Open battery box clips (1).

2 Remove battery box cover (2).

3 Clean battery box (3) as follows:

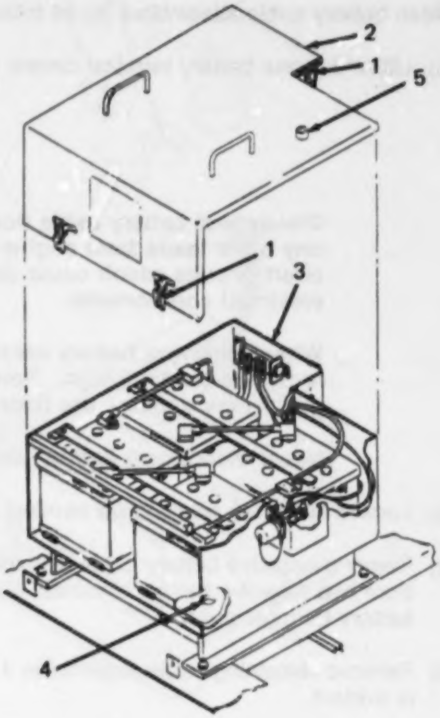
(a) Wipe dirt from exterior of battery box (3) and battery box cover (2) with a clean dry cloth.

(b) Examine exterior bottom of battery box (3) to be sure that the four drain holes (4) are open.

(c) If drain holes (4) are obstructed, gently brush them clean with a wire brush.

(d) Check that battery box vent (5) is clear.

(e) If vent is obstructed, remove dirt or debris.



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/ REPAIR/REPLACE (CONT)

4 Clean battery cable assemblies (6) as follows:

(a) Lift and rotate battery terminal covers (7) to expose terminals (8) and terminal lugs (9).

CAUTION

Disconnect battery cable from negative battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

When removing battery cable, use battery terminal puller to remove loosened terminal lugs. Forcing battery terminal lugs off without using puller may damage the battery posts.

Never disconnect battery while alternator is operating.

(b) Loosen nuts (10) on negative terminal lugs (9).

(c) Remove negative battery cable assembly (6) from two negative battery terminals (8) using battery terminal puller.

(d) Remove remaining cable assemblies if corrosion is evident.

(e) Use battery brush (11) to clean terminal lugs (9) and terminals (8).

WARNING

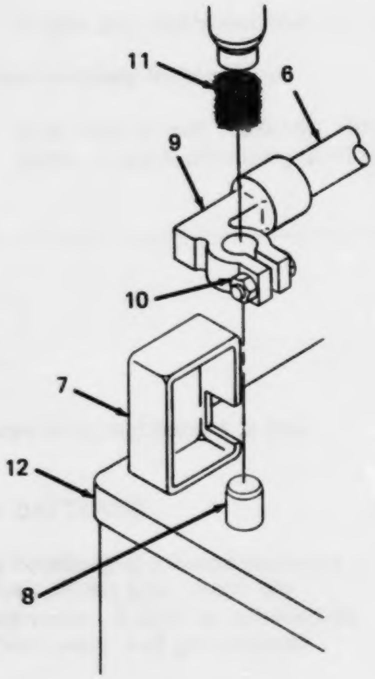
Connect positive battery cables to battery first to prevent shocks to personnel and damage to other electrical system components.

(f) Install cable terminal lugs (9) to terminals (8) and tighten nuts (10).

(g) Apply grease to lugs and terminals to prevent corrosion.

(h) Rotate battery terminal covers (7) onto terminals (8).

5 Clean batteries (12) by wiping dirt and deposits from top surface with a clean cloth and solution of baking soda and water.



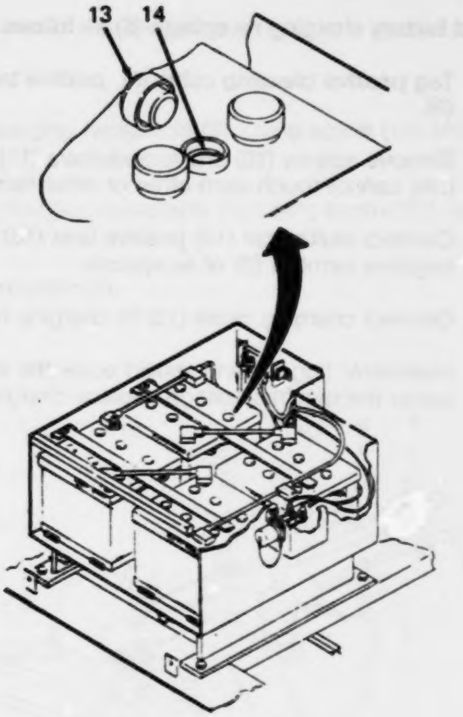
2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

6 Maintain proper battery electrolyte level as follows:

(a) Remove battery filler caps (13).

(b) Check electrolyte level. If low, add distilled water up to split rings (14).

(c) Install battery filler caps (13).



7 Install battery box cover (2) and secure with battery box clips (1).

TESTING:

1 Open battery box clips (1).

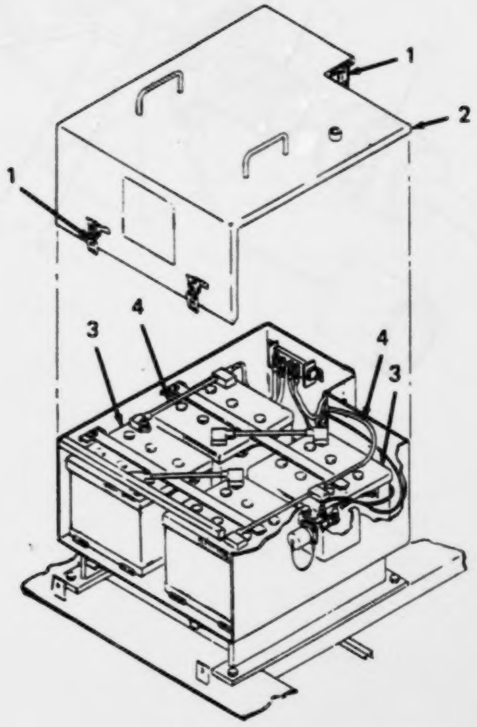
2 Remove battery box cover (2).

WARNING

Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of water and get medical attention.

3 Check specific gravity of batteries (3).

4 Remove battery cables (4) and perform continuity check.



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

5 Test battery charging receptacle (5) as follows:

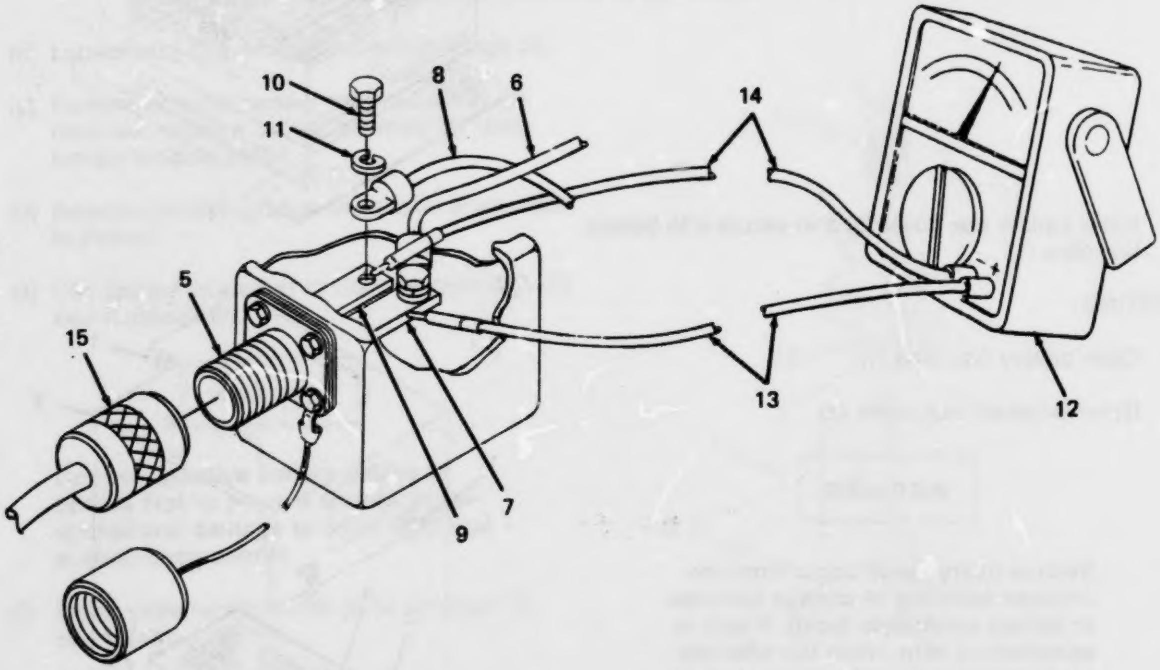
(a) Tag positive charging cable (6), positive terminal (7), negative charging cable (8), and negative terminal (9).

(b) Remove screws (10) and lockwashers (11) that secure cables to terminals and place cables aside so that they cannot touch each other or other terminals.

(c) Connect multimeter (12) positive lead (13) to positive terminal (7) of receptacle and negative lead (14) to negative terminal (9) of receptacle.

(d) Connect charging cable (15) to charging receptacle (5) and apply charging power.

(e) Multimeter (12) reading should equal the charging voltage applied (approximately 24 volts). If reading is below the required voltage, replace charging receptacle (5).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

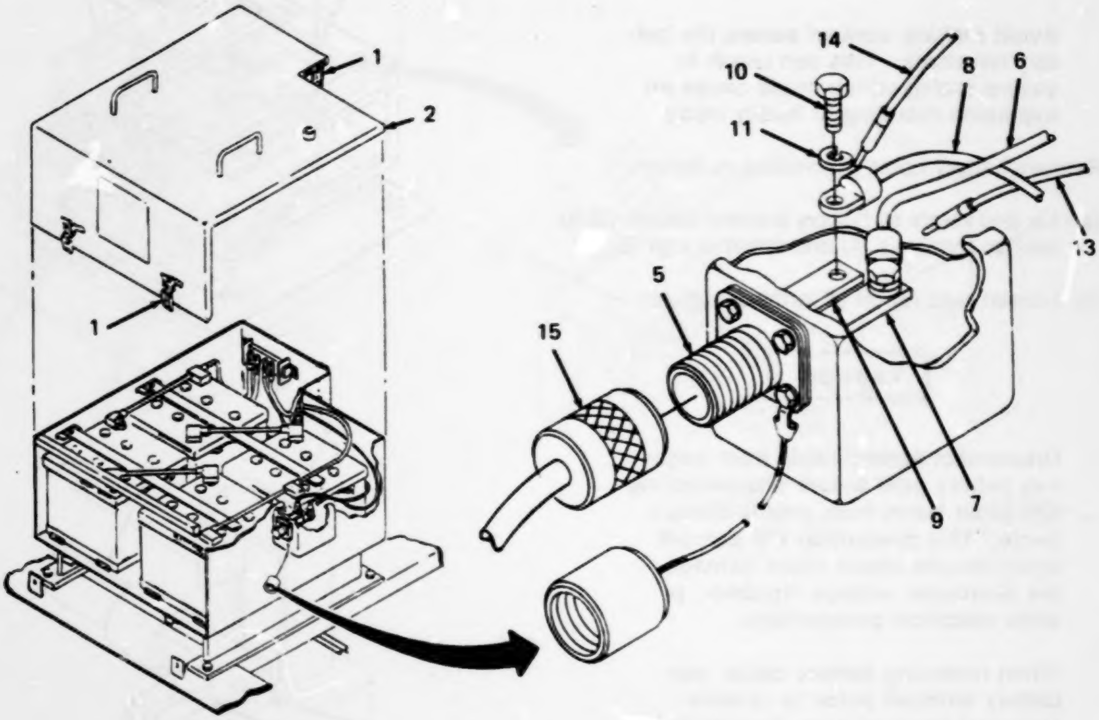
(f) Remove multimeter leads (13 and 14).

(g) Remove charging cable (15).

(h) Connect positive cable (6) to positive terminal (7) of charging receptacle (5), using screw (10) and lockwasher (11).

(i) Connect negative cable (8) to negative terminal (9) of charging receptacle (5), using screw (10) and lockwasher (11).

(j) Install battery box cover (2) and secure with battery box clips (1).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

REMOVAL:

1 Open battery box clips (1).

2 Remove battery box cover (2).

WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of the battery.

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

3 Remove battery cable assemblies as follows:

(a) Lift and rotate all battery terminal covers (3) to expose terminals (4) and terminal lugs (5).

(b) Loosen nuts (6) on all terminal lugs (5).

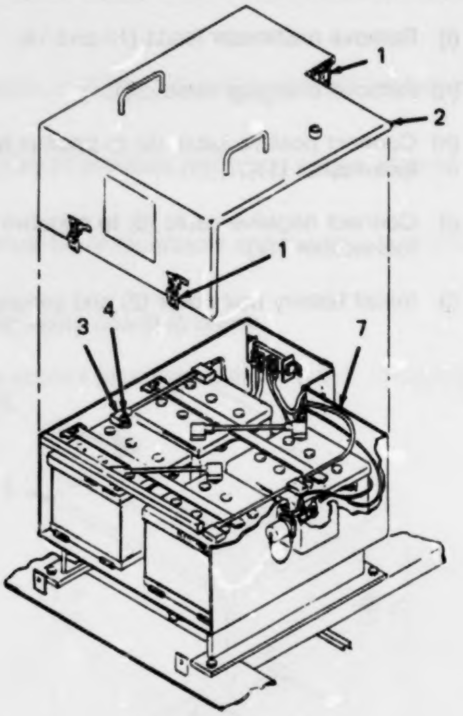
CAUTION

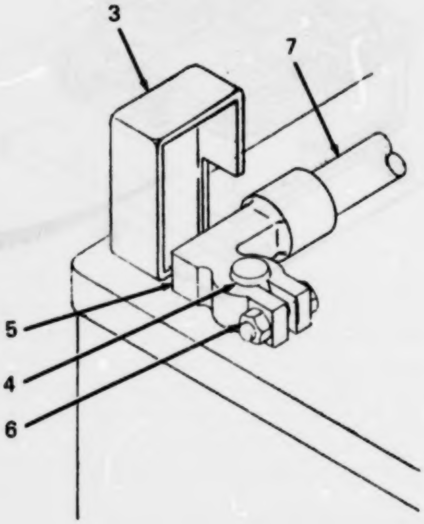
Disconnect battery cable from negative battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

When removing battery cable, use battery terminal puller to remove loosened terminal lugs. Forcing battery terminal lugs off without using puller may damage the battery posts.

Never disconnect battery while alternator is operating.

(c) Remove negative battery cable assembly (7) from two negative battery terminals (4) using battery terminal puller.





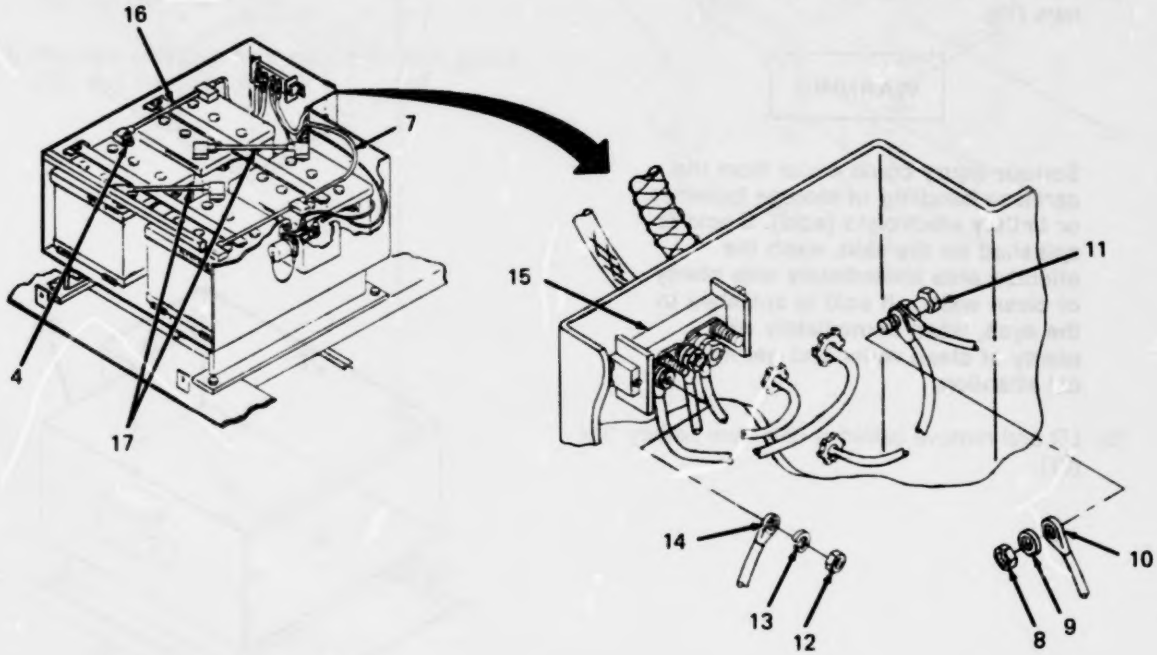
2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(d) Remove nut (8) and washer (9) securing negative battery cable lug (10) to terminal (11) and remove negative battery cable assembly (7).

(e) Remove nut (12) and lockwasher (13) securing positive battery cable lug (14) to terminal block (15).

(f) Remove positive cable assembly (16) from two positive battery terminals (4) using battery terminal puller.

(g) Remove two jumper cable assemblies (17) from battery terminals (4) using battery terminal puller.



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

4 Remove batteries as follows:

WARNING

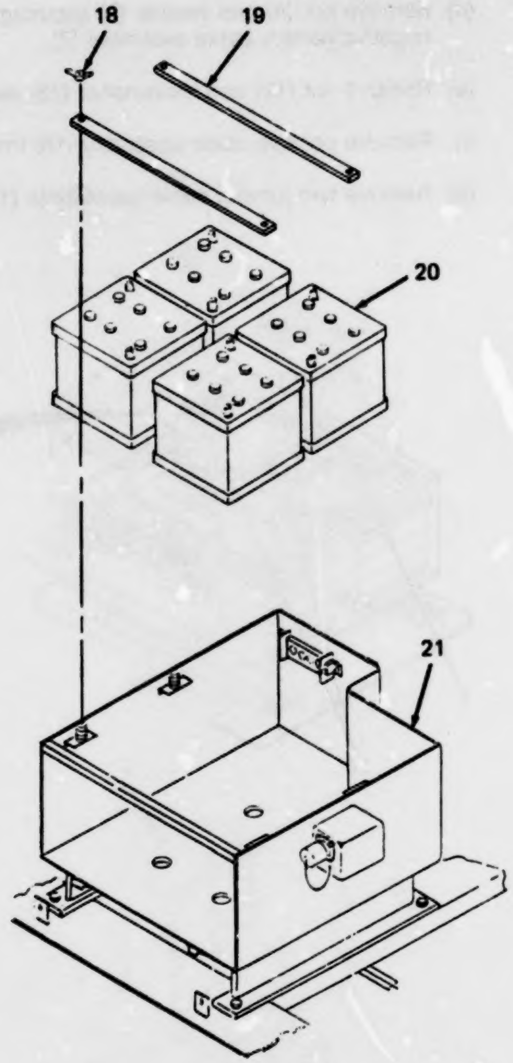
Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

(a) Remove four wingnuts (18) and two hold-down bars (19).

WARNING

Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

(b) Lift and remove batteries (20) from battery box (21).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

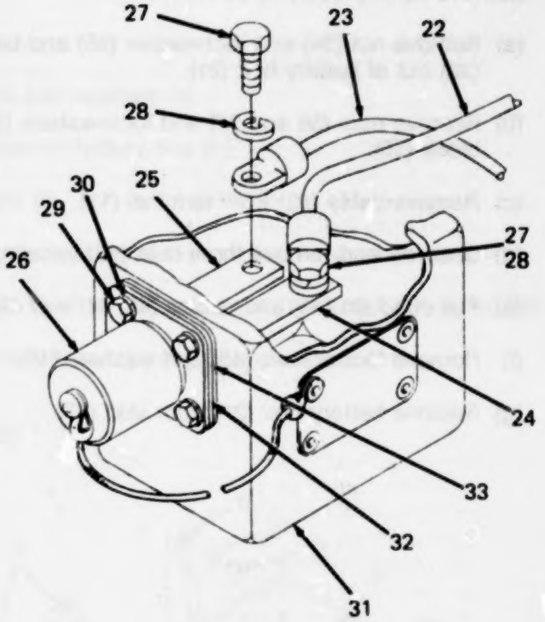
5 Remove charging receptacle as follows:

(a) Tag positive charging cable (22), negative charging cable (23), and positive terminal (24) and negative terminal (25) of charging receptacle (26).

(b) Remove screws (27) and lockwashers (28) that secure cables to terminals.

(c) Remove four screws (29) and lockwashers (30) that secure charging receptacle (26) to bracket (31).

(d) Remove charging receptacle (26) with gasket (32) and insulator (33).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/ REPAIR/REPLACE (CONT)

6 Remove battery box (21) as follows:

(a) Remove nut (34) and lockwasher (35) and take positive charging cable (22) and negative charging cable (23) out of battery box (21).

(b) Remove nuts (36 and 37) and lockwashers (38 and 39) and remove cables (40 and 41) from terminal block (15).

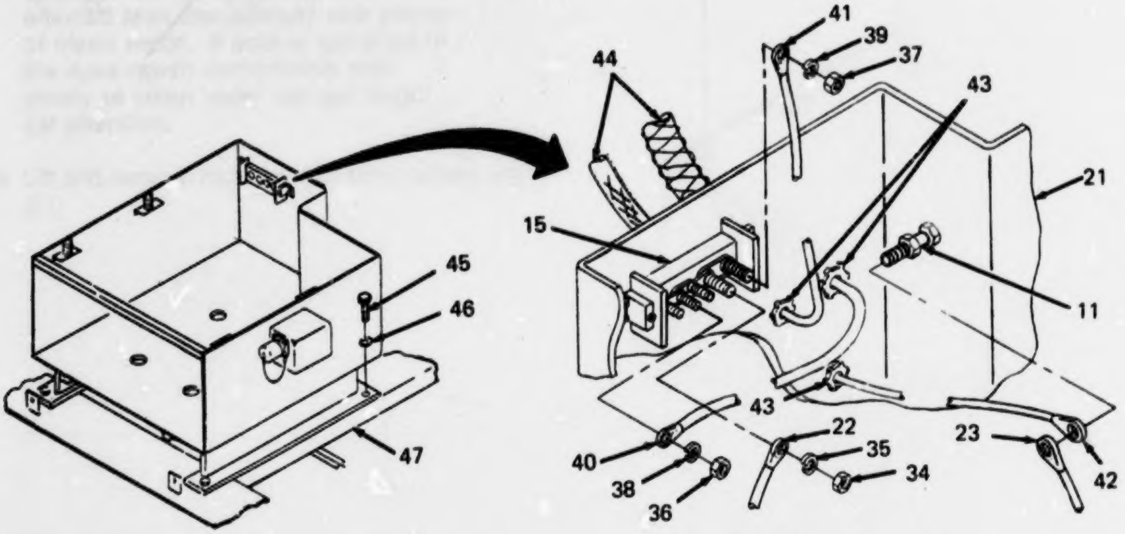
(c) Remove cable (42) from terminal (11).

(d) Unscrew and remove three nuts (43) securing conduits (44) to battery box (21).

(e) Pull conduits (44) and cables (40, 41, and 42) away from battery box (21).

(f) Remove four screws (45) and washers (46).

(g) Remove battery box (21) from skid (47).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

INSTALLATION:

1 Install battery box (1) as follows:

(a) Install battery box (1) to skid (2) using four screws (3) and washers (4).

(b) Insert cables (5, 6, and 7) through their respective holes in battery box (1).

(c) Secure three conduits (8) to battery box (1) using nuts (9).

(d) Connect cables (5 and 6) to terminal block (10) using nuts (11 and 12) and lockwashers (13 and 14).

(e) Connect cable (7) and negative charging cable (15) to terminal (16) using nut (17) and lockwasher (18).

(f) Connect positive charging cable (19) to terminal block (10) using nut (20) and washer (21).

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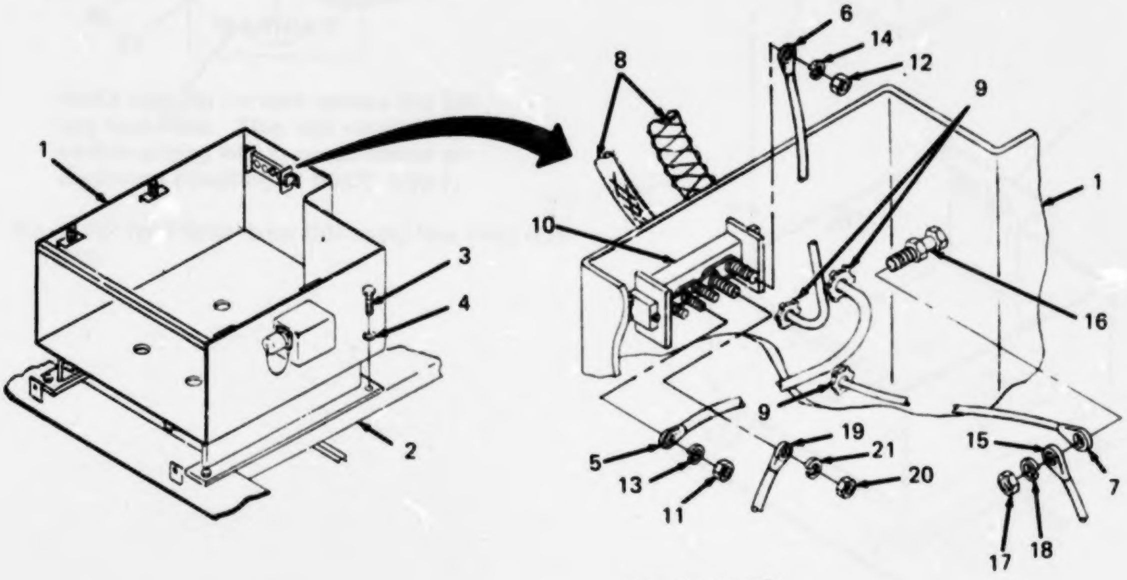


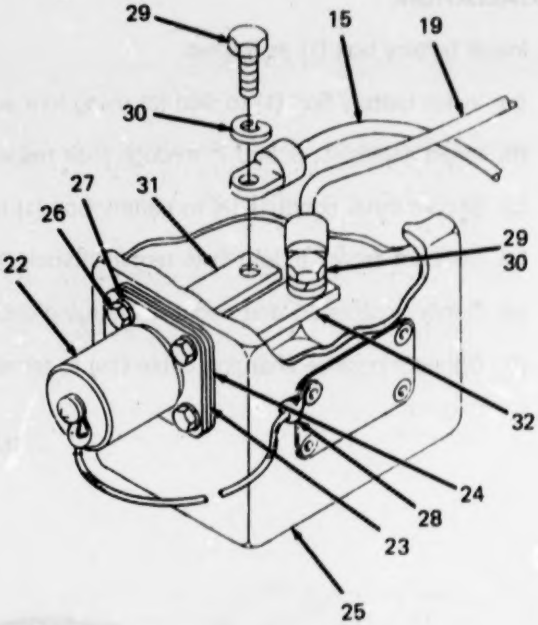
2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/ REPAIR/REPLACE (CONT)

2 Install charging receptacle (22) as follows:

(a) Place gasket (23) and insulation (24) on flange of charging receptacle (22) and insert receptacle, terminals first, into hole in bracket (25).

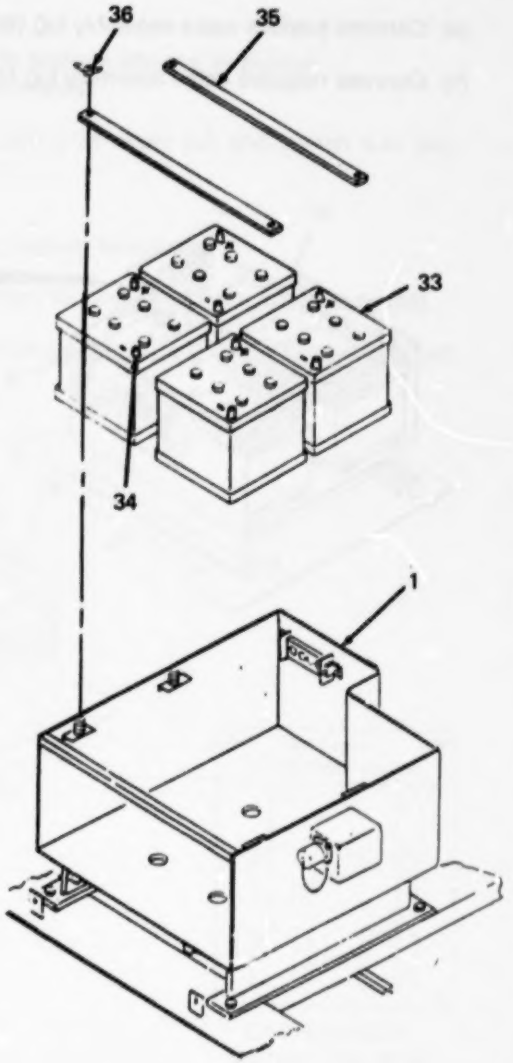
(b) Secure charging receptacle (22) to bracket (25) using four screws (26) and lockwashers (27). Be sure that lanyard eyelet (28) is secured to bracket by one of the screws.

(c) Using two screws (29) and lockwashers (30), secure cables (15 and 19) to terminals (31 and 32) of charging receptacle (22).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

3 Install batteries as follows:



WARNING

Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

(a) Place batteries (33) into battery box (1) so that terminals (34) are located as shown in figure.

WARNING

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

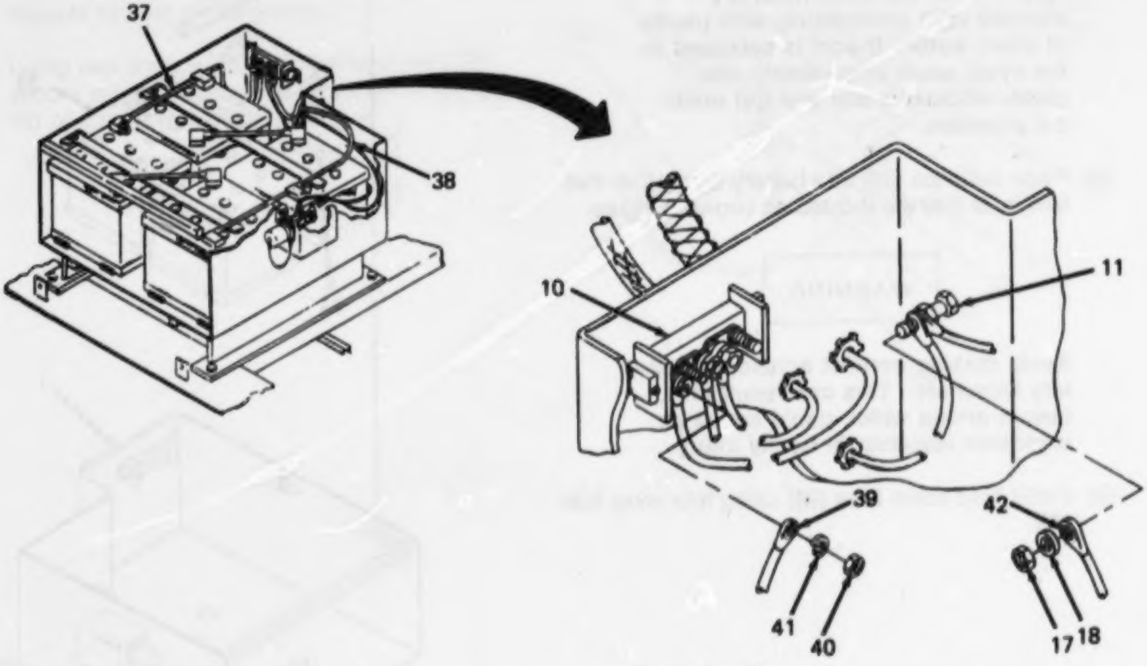
(b) Install hold-down bars (35) using four wing nuts (36).

2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/ REPAIR/REPLACE (CONT)

4 Install positive battery cable (37) and negative battery cable (38) as follows:

(a) Connect positive cable assembly lug (39) to terminal block (10) using nut (40) and lockwasher (41).

(b) Connect negative cable assembly lug (42) to terminal (11) using nut (17) and washer (18).



2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

WARNING

Connect positive battery cables to battery first to prevent shocks to personnel and damage to other electrical system components.

(c) Install positive battery cable assembly (37) to appropriate battery terminals (34) and tighten nuts (43).

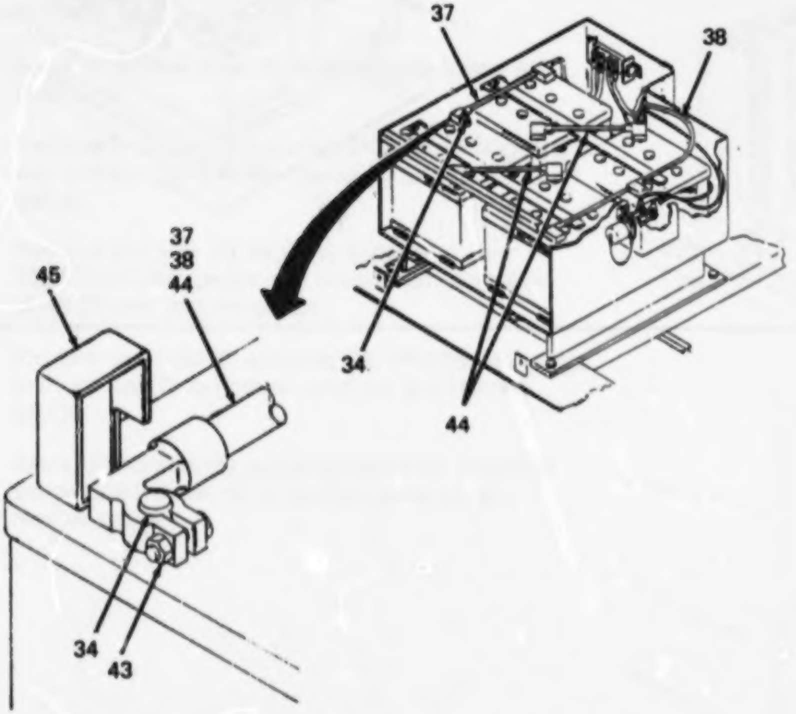
NOTE

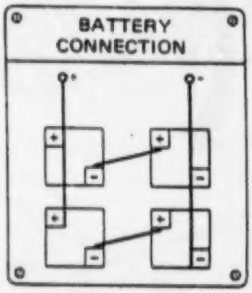
Use battery box wiring diagram to locate proper battery terminals.

(d) Install two jumper cable assemblies (44) to appropriate battery terminals (34) and tighten nuts (43).

(e) Install negative battery cable assembly (38) to appropriate battery terminals (34) and tighten nuts (43).

(f) Rotate all battery terminal covers (45) onto terminals (34).



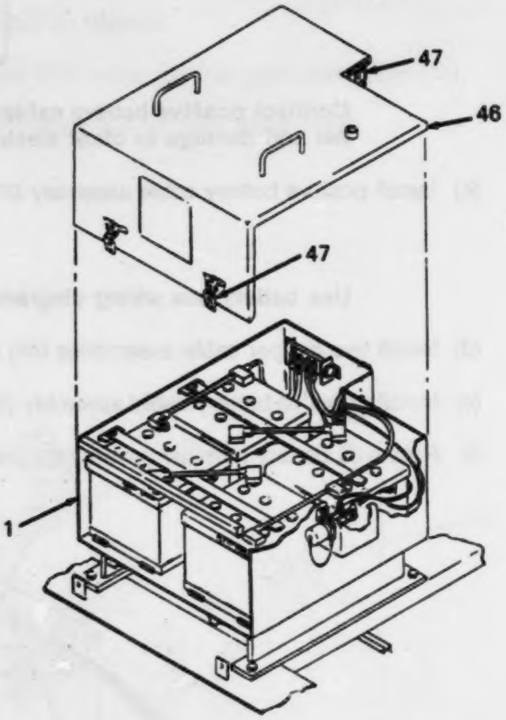


BATTERY BOX WIRING DIAGRAM

2-27. BATTERIES, BATTERY BOX, AND BATTERY CABLE ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

5 **Install battery box cover (46) to battery box (1).**

6 **Secure battery box clips (47).**



2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE

This task covers: a. Removal b. Repair c. Testing/Inspection d. Installation

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Insulating tape (Item 32, Appendix C)

Suitable tags

Condition Description

Engine shut down and cool

General Safety Instructions

Well ventilated area

REMOVAL:

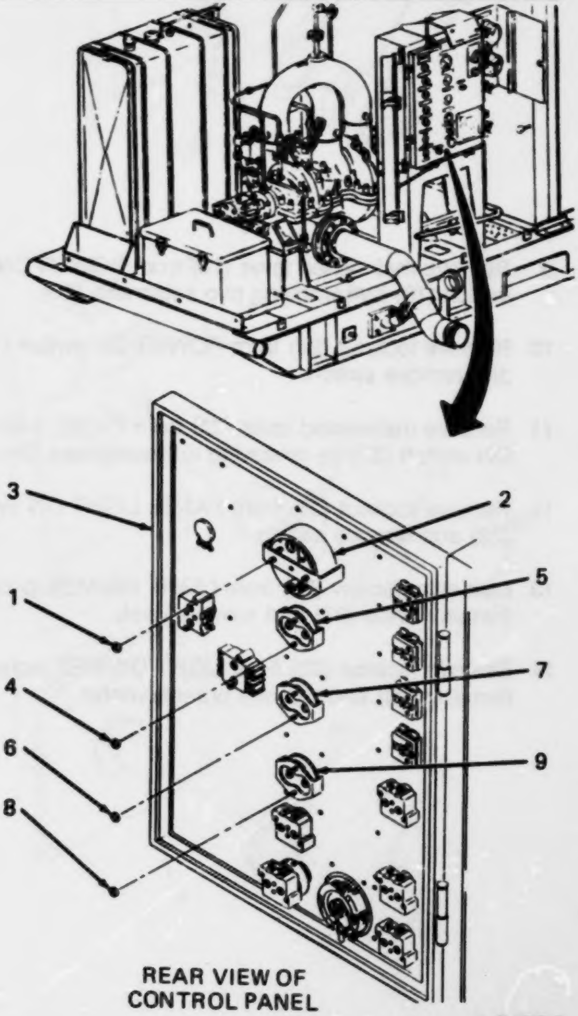
1 Tag and remove wires from gauges, switches, and indicators.

2 Remove two nuts (1) securing ENGINE RPM gauge and bracket (2) to control panel (3) and remove gauge.

3 Remove two nuts (4) securing ENGINE TEMPERATURE gauge and bracket (5) to control panel (3) and remove gauge.

4 Remove two nuts (6) securing OIL PRESSURE gauge and bracket (7) to control panel (3) and remove gauge.

5 Remove two nuts (8) securing BATTERY CHARGE gauge and bracket (9) to control panel (3) and remove gauge.



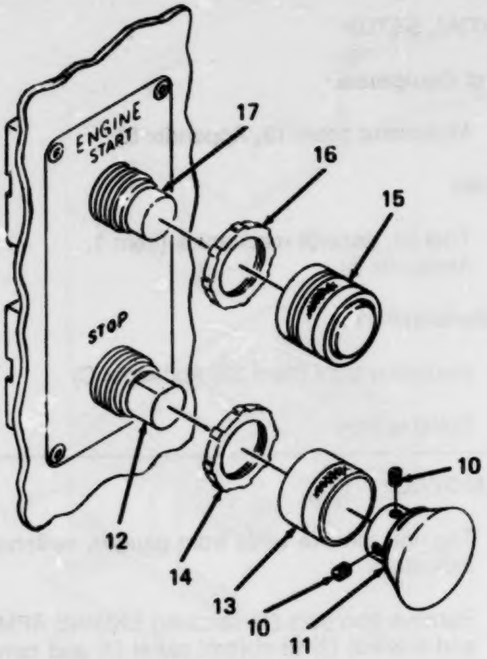
REAR VIEW OF CONTROL PANEL

2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

6 Loosen two setscrews (10) and remove button (11) from ENGINE STOP pushbutton switch (12).

7 Remove cap (13) and sealing locknut (14) and remove ENGINE STOP pushbutton switch (12).

8 Remove cap (15) and sealing locknut (16) and remove ENGINE START pushbutton switch (17).


ENGINE START
STOP
17
16
15
10
12
14
13
10
11

9 Remove maintained lever (18) from POWER ON switch (19) by removing two setscrews (20).

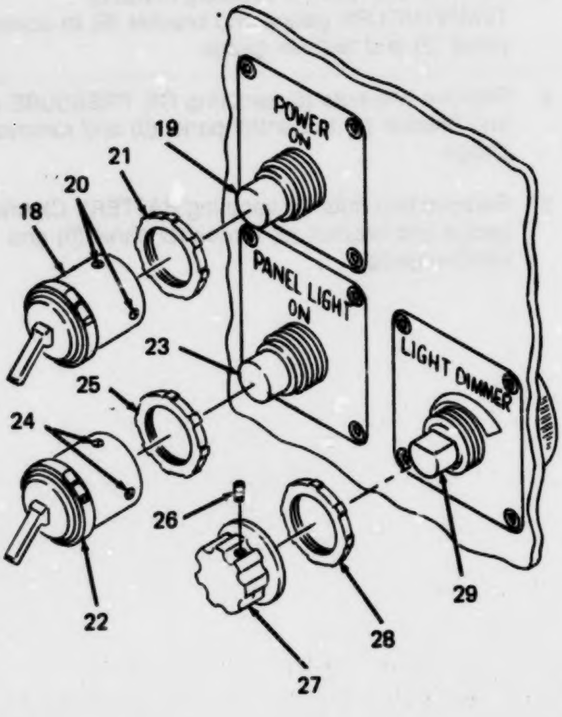
10 Remove locknut (21) from POWER ON switch (19) and remove switch.

11 Remove maintained lever (22) from PANEL LIGHT ON switch (23) by removing two setscrews (24).

12 Remove locknut (25) from PANEL LIGHT ON switch (23) and remove switch.

13 Loosen setscrew (26) from LIGHT DIMMER potentiometer knob (27) and remove knob.

14 Remove locknut (28) from LIGHT DIMMER potentiometer (29) and remove potentiometer.


POWER ON
PANEL LIGHT ON
LIGHT DIMMER
19
21
20
18
23
25
24
26
22
27
28
29

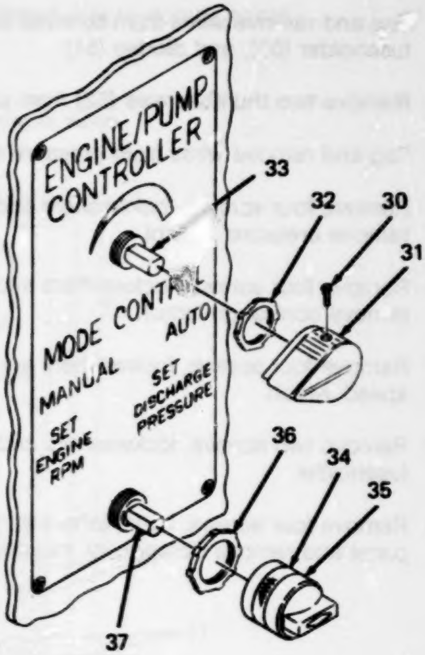
2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

15 Loosen setscrew (30) from ENGINE PUMP CONTROLLER knob (31) and remove knob.

16 Remove locknut (32) from ENGINE PUMP CONTROLLER switch (33) and remove switch.

17 Remove cap (34) from MODE CONTROL MANUAL/ AUTO knob (35).

18 Remove locknut (36) from MODE CONTROL MANUAL/AUTO switch (37) and remove switch.


ENGINE/PUMP CONTROLLER
MODE CONTROL
MANUAL
AUTO
SET ENGINE RPM
SET DISCHARGE PRESSURE
33
32
30
31
36
34
35
37

NOTE

LOW SUCTION PRESSURE, HIGH ENGINE TEMPERATURE, LOW OIL PRESSURE, and ENGINE OVERSPEED indicators are removed as in steps 19 and 20.

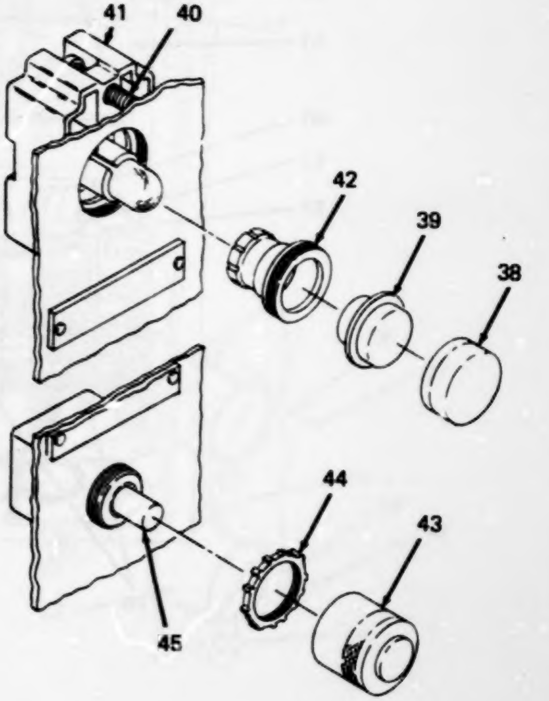
19 Remove lens (38) and lens cover (39).

20 Loosen two screws (40) from rear of indicator (41) then turn lampholder (42) and remove.

NOTE

ALARM RESET and PRESS TO TEST LAMPS switches are removed as in step 21.

21 Remove pushbutton cap (43) and locknut (44) from pushbutton (45) and remove pushbutton.


41
40
42
39
38
44
43
45

2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

22 Tag and remove wires from terminal boards (46), relays (47), speed switch (48), control governor (49), fuseholder (50), and diodes (51).

23 Remove two thumbscrews (52) from pressure control (53) and remove cover (54).

24 Tag and remove wires from pressure control.

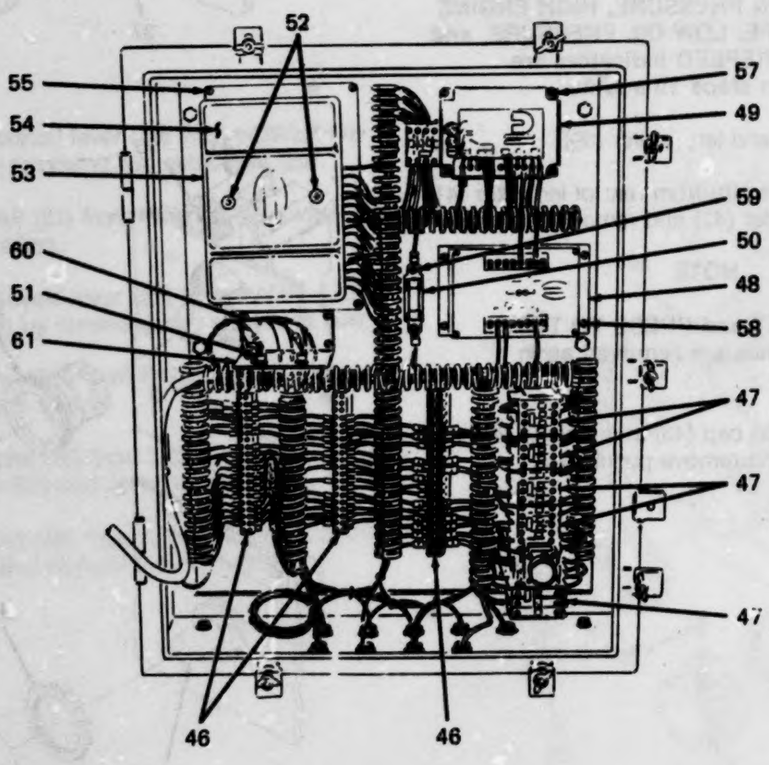
25 Remove four screws, lockwashers and washers (55) securing pressure control (56) to control panel and remove pressure control.

26 Remove four screws, lockwashers and washers (57) securing control governor (49) to control panel and remove control governor.

27 Remove four screws, lockwashers and washers (58) securing speed switch (48) to control panel and remove speed switch.

28 Remove two screws, lockwashers and washers (59) securing fuseholder (50) to control panel and remove fuseholder.

29 Remove four screws, lockwashers and washers (60) securing component mounting bracket (61) to control panel and remove component mounting bracket.

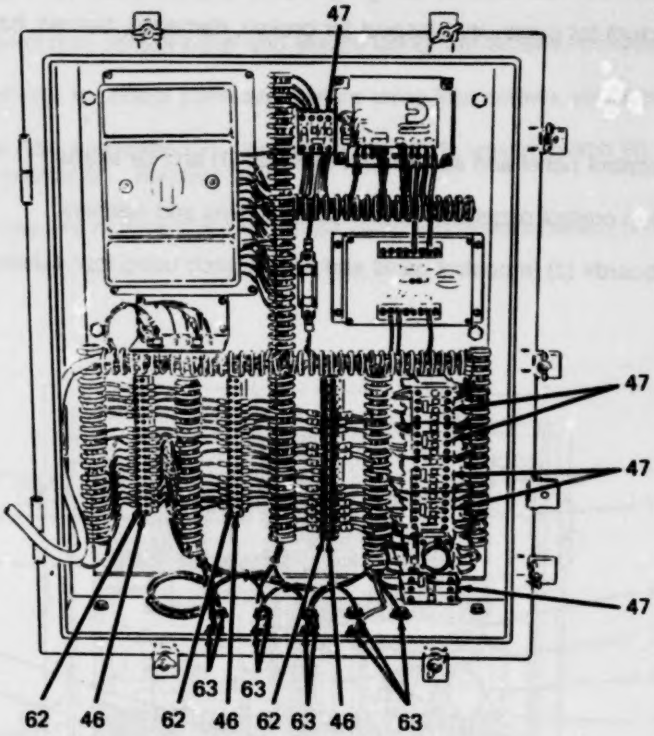


2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

30 Remove four screws and lockwashers (62) securing each terminal board (46) to control panel.

31 Remove screws and washers securing relays (47) to control panel.

32 Remove locknuts (63) securing connectors to control panel and remove wires.


47
47
47
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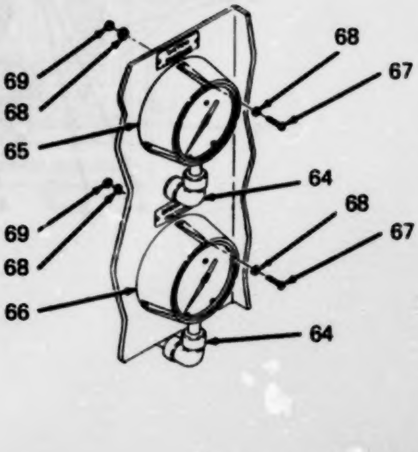
46
63

33 Disconnect plumbing (64) from SUCTION PRESSURE (65) and DISCHARGE PRESSURE (66) gauges.

34 Remove six screws (67), washers and lockwashers (68), and nuts (69) securing each SUCTION PRESSURE (65) and DISCHARGE PRESSURE (66) gauge.


68
67
69
68
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64
68
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68
66
64

2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

REPAIR:

Replace any wires or connectors that are frayed, damaged, burned, or broken. Replace entire wiring harness if necessary.

TESTING/INSPECTION:

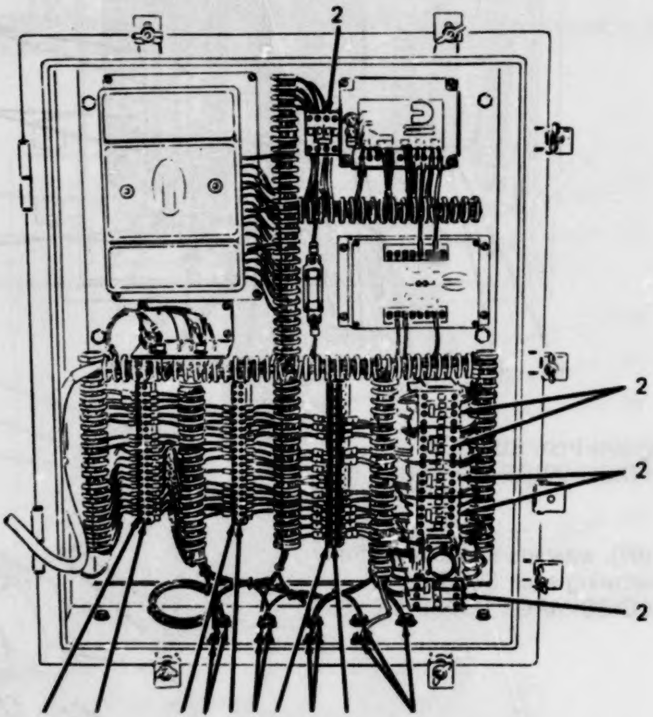
Test wires and connectors for continuity. Inspect for broken, damaged, burned, frayed, or abraded wires or connectors.

INSTALLATION:

1 Position wires in control panel and secure with locknuts (1) and tie straps.

2 Position relays (2) in control panel and secure using screws and washers.

3 Position terminal boards (3) in control panel and secure each using four screws and lockwashers (4).



2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

4 Position component mounting bracket (5) in control panel and secure using four screws, lockwashers and washers (6).

5 Position fuseholder (7) in control panel and secure using two screws, lockwashers, and washers (8).

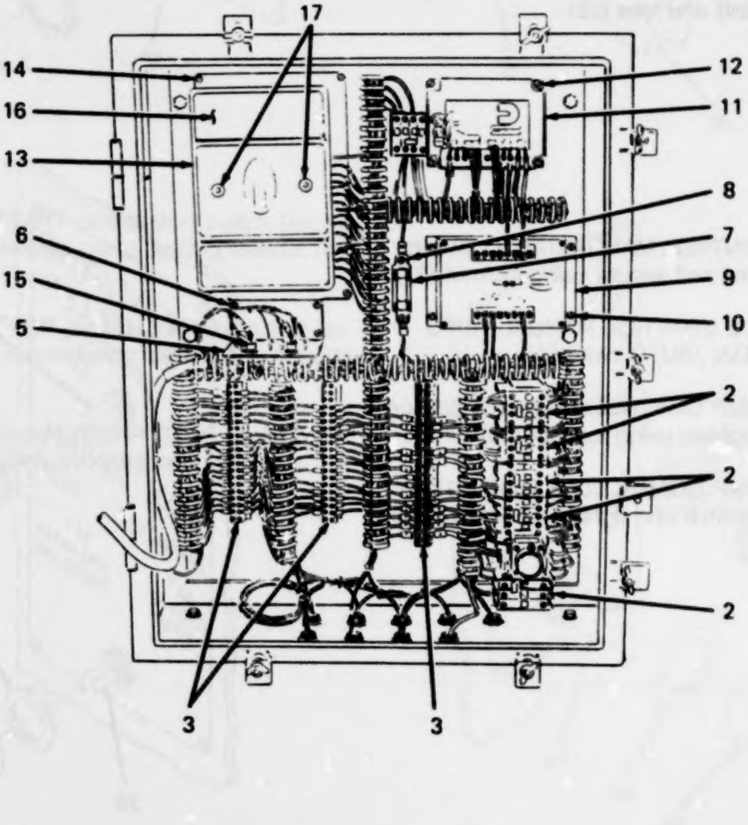
6 Position speed switch (9) in control panel and secure using four screws, lockwashers, and washers (10).

7 Position control governor (11) in control panel and secure using four screws, lockwashers, and washers (12).

8 Position pressure control (13) in control panel and secure using four screws, lockwashers, and washers (14).

9 Connect wires to diodes (15), fuseholder (7), control governor (11), speed switch (9), pressure control (13), relays (2), and terminal boards (3). Remove tags.

10 Position cover (16) on pressure control (13) and secure using two thumbscrews (17).



2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

NOTE

ALARM RESET and PRESS TO TEST LAMPS switches are installed as in step 11.

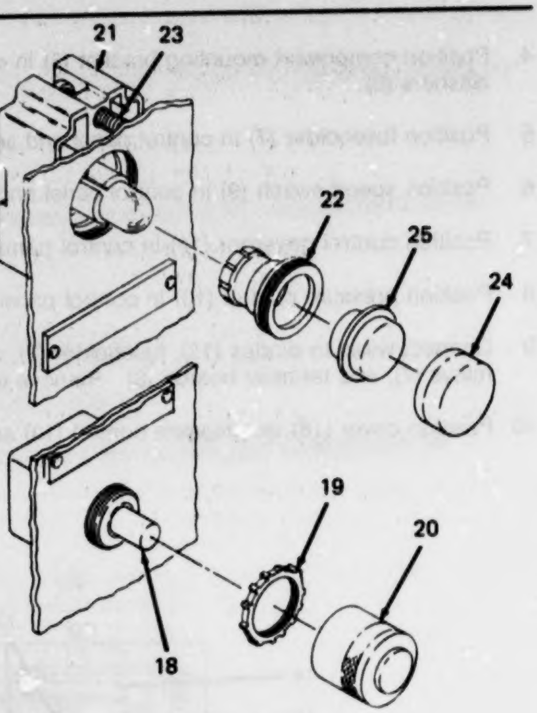
11 Position pushbutton (18) on control panel and secure using locknut (19) and pushbutton cap (20).

NOTE

LOW SUCTION PRESSURE, HIGH ENGINE TEMPERATURE, LOW OIL PRESSURE, and ENGINE OVERSPEED indicators are installed as in steps 12 and 13.

12 Position indicator (21) on rear of panel. Install lampholder (22) from front of panel and turn. Tighten two screws (23) on rear of indicator.

13 Install lens cover (24) and lens (25).

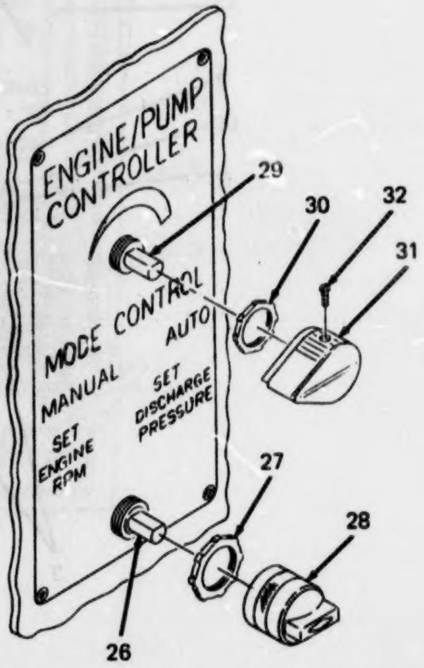

21
23
22
25
24
19
20
18

14 Position MODE CONTROL MANUAL/AUTO switch (26) on control panel and secure using locknut (27).

15 Install cap on MODE CONTROL MANUAL/AUTO knob (28) on MANUAL/AUTO switch.

16 Install ENGINE/PUMP CONTROLLER switch (29) on control panel and tighten using locknut (30).

17 Install ENGINE/PUMP CONTROLLER knob (31) on MODE CONTROL switch and tighten setscrew (32).


ENGINE/PUMP CONTROLLER
29
30
32
31
MODE CONTROL
AUTO
MANUAL
SET DISCHARGE PRESSURE
SET ENGINE RPM
27
28
26

2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

18 Position LIGHT DIMMER potentiometer (33) on control panel and secure using locknut (34).

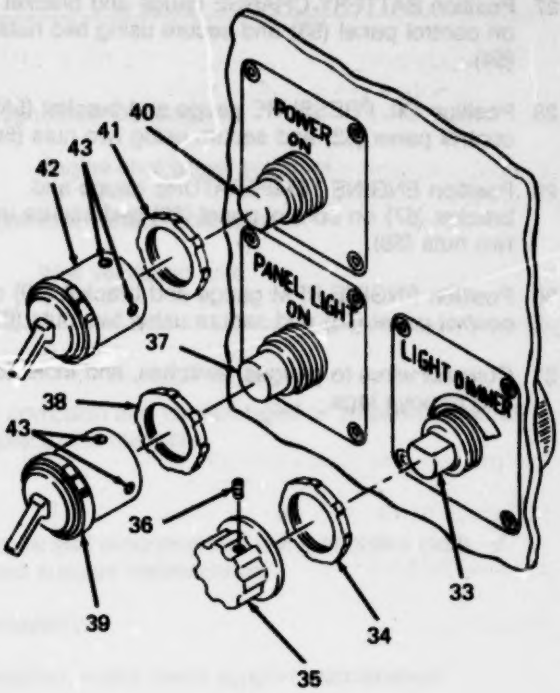
19 Position LIGHT DIMMER potentiometer knob (35) on LIGHT DIMMER potentiometer and secure using setscrew (36).

20 Position PANEL LIGHT ON switch (37) on control panel and secure using locknut (38).

21 Install maintained lever (39) on PANEL LIGHT ON switch (37) and tighten two setscrews (43).

22 Position POWER ON switch (40) on control panel and secure using locknut (41).

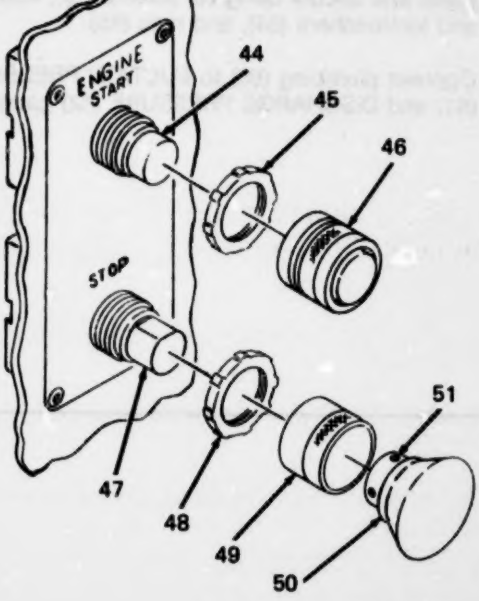
23 Install maintained lever (42) on POWER ON switch (40) and tighten two setscrews (43).


40
41
43
42
POWER ON
PANEL LIGHT ON
LIGHT DIMMER
37
38
43
36
33
39
34
35

24 Position ENGINE START pushbutton switch (44) on control panel and secure using sealing locknut (45) and cap (46).

25 Position ENGINE STOP pushbutton switch (47) on control panel and secure using sealing locknut (48) and cap (49).

26 Position button (50) on ENGINE STOP pushbutton switch (47) and tighten two setscrew (51).


ENGINE START
44
45
46
STOP
51
47
48
49
50

2-28. WIRING, GAUGES, SWITCHES, AND INDICATORS TEST/REPAIR/REPLACE (CONT)

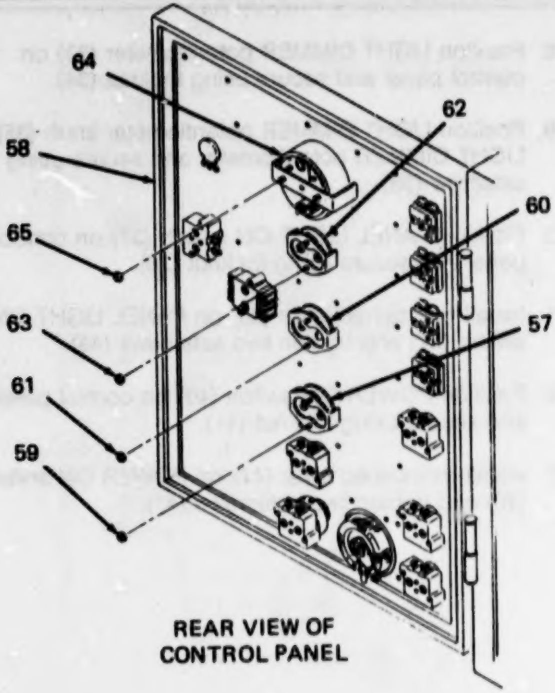
27 Position BATTERY CHARGE gauge and bracket (52) on control panel (53) and secure using two nuts (54).

28 Position OIL PRESSURE gauge and bracket (55) on control panel (53) and secure using two nuts (56).

29 Position ENGINE TEMPERATURE gauge and bracket (57) on control panel (53) and secure using two nuts (58).

30 Position ENGINE RPM gauge and bracket (59) on control panel (53) and secure using two nuts (60).

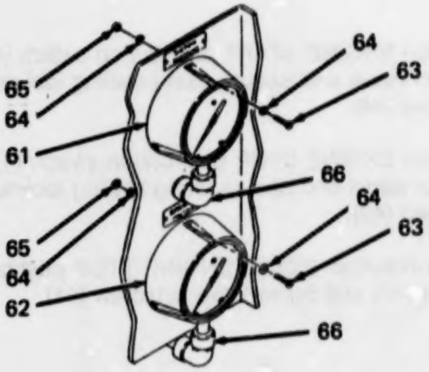
31 Connect wires to gauges, switches, and indicators and remove tags.



REAR VIEW OF CONTROL PANEL

32 Position SUCTION PRESSURE (61) and DISCHARGE PRESSURE (62) gauges on control panel and secure using six screws (63), washers and lockwashers (64), and nuts (65).

33 Connect plumbing (66) to SUCTION PRESSURE (61) and DISCHARGE PRESSURE (62) gauges.



2-29. CABINET ENCLOSURE REPAIR

This task covers: a. Inspection b. Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Condition Description

Engine shut down and cool

General Safety Instructions

Well ventilated area

INSPECTION:

Inspect cabinet enclosure and mounting feet for cracks, rust, corrosion and for damaged or stripped threads. Check that identification and performance data plates are in place and readable.

REPAIR:

1 Remove minor dents, rust, or corrosion on cabinet enclosure and mounting feet using abrasive cloth. If severely damaged, dented, rusted, or corroded notify direct support maintenance.

2 Replace identification and performance data plates as necessary.

3 If any further maintenance on the cabinet enclosure is required, notify direct support maintenance.

2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE

This task covers: a. Removal b. Testing/Repair/Inspection c. Installation

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Dc power supply (Item 16, Appendix B)

Dc generator (Item 17, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Soldering iron (Item 2, Appendix B)

Materials/Parts

Suitable tags

Equipment Condition Reference	Condition Description
	Engine shut down and cool
Paragraph 2-27	Battery cables disconnected
Paragraph 2-28	Suction and discharge pressure gauges removed

General Safety Instructions

Well ventilated area

REMOVAL:

CAUTION

Disconnect negative battery cable before attempting repairs on electrical system.

1 Tag and remove wire from top of speed sensor (1).

2 Unscrew and remove speed sensor (1).

3 Tag and remove wires from low oil pressure switch (2).

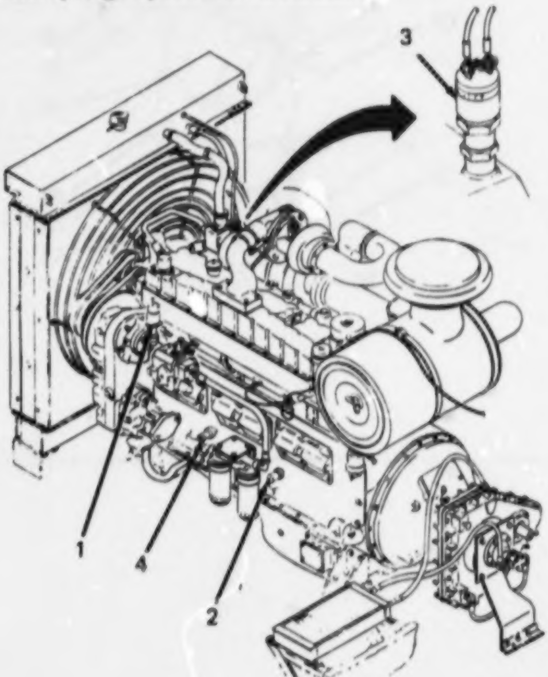
4 Unscrew and remove low oil pressure switch (2).

5 Tag and remove two wires from high coolant temperature switch (3).

6 Unscrew and remove high coolant temperature switch (3).

7 Remove connector from lube oil pressure transmitter (4).

8 Unscrew and remove lube oil pressure transmitter (4).



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

9 Remove connector from coolant temperature transmitter (5).

10 Unscrew and remove coolant temperature transmitter (5).

11 Remove connector from magnetic pickup (6).

12 Unscrew and remove magnetic pickup (6).

13 Remove two screws and washers (7) securing clutch limit switch cover (8) to switch (9).

14 Tag and remove wires from clutch limit switch (9).

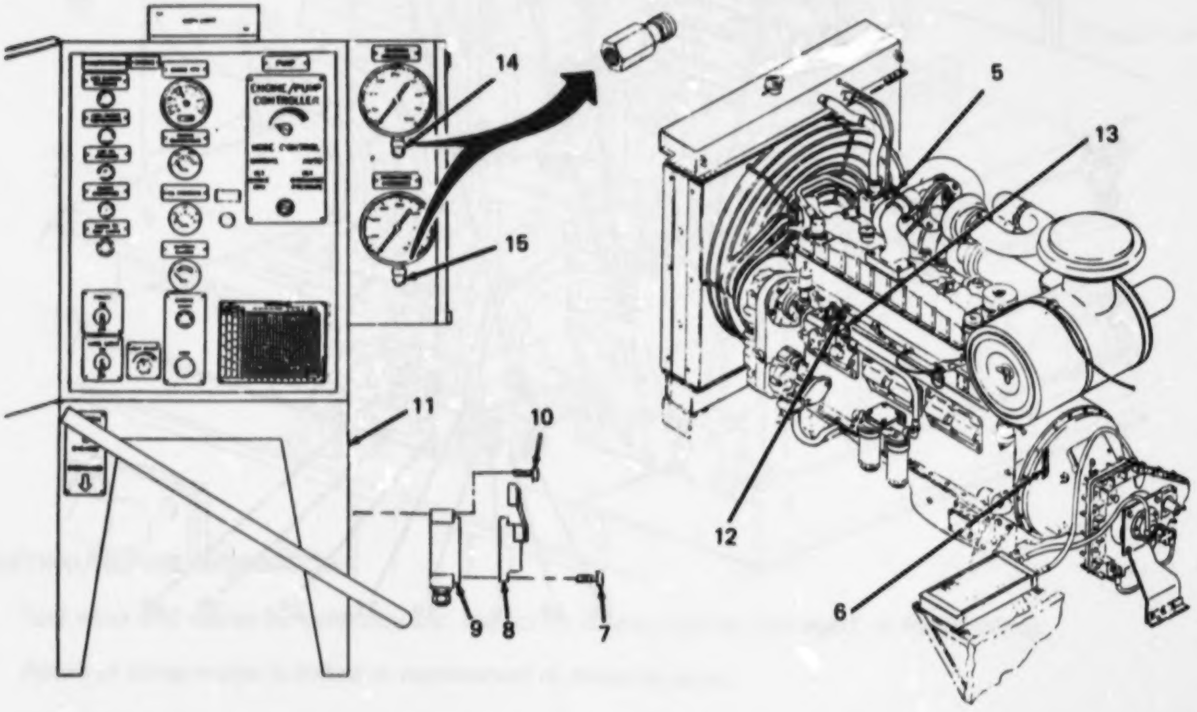
15 Remove four screws (10) securing clutch limit switch (9) to control panel (11).

16 Tag and remove wires from electronic fuel control actuator (12).

17 Tag and remove wires from fuel solenoid valve (13).

18 Remove fluid dampener (14) from the suction pressure line.

19 Remove fluid dampener (15) from the discharge pressure line.



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

20 Remove connector J1 (16) from junction box JB1 (17).

21 Remove nut (18) securing pump delivery pressure transmitter (19) to discharge transducer valve (20).

22 Remove nut (21) securing cable to bracket (22) and remove cable.

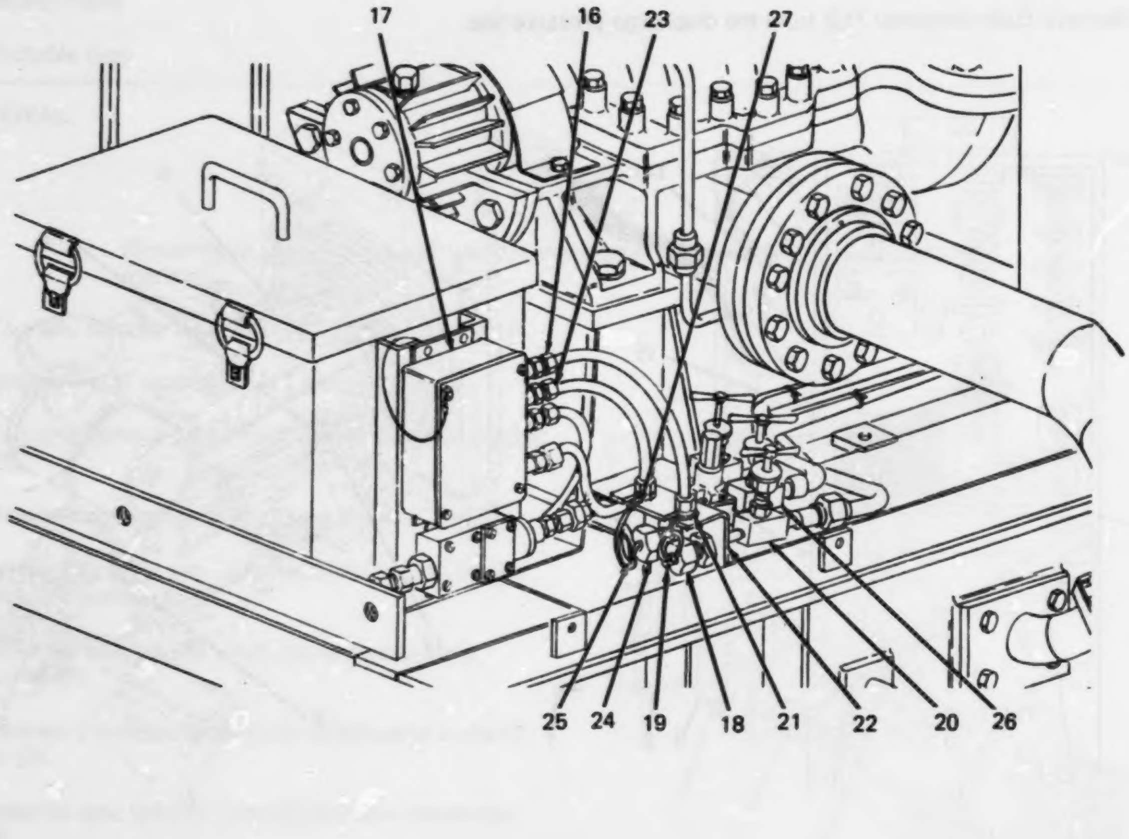
23 Separate connector J1 (16), tag and desolder wires from connector, and remove pump delivery pressure transmitter (19) and associated wiring.

24 Remove connector J2 (23) from junction box JB1 (17).

25 Remove nut (24) securing pump suction pressure transmitter (25) to suction transducer valve (26).

26 Remove nut (27) securing cable to bracket (22) and remove cable.

27 Separate connector J2 (23), tag and desolder wires from connector, and remove pump suction pressure transmitter (25) and associated wiring.



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

28 Remove connector J3 (28) from junction box JB1 (17).

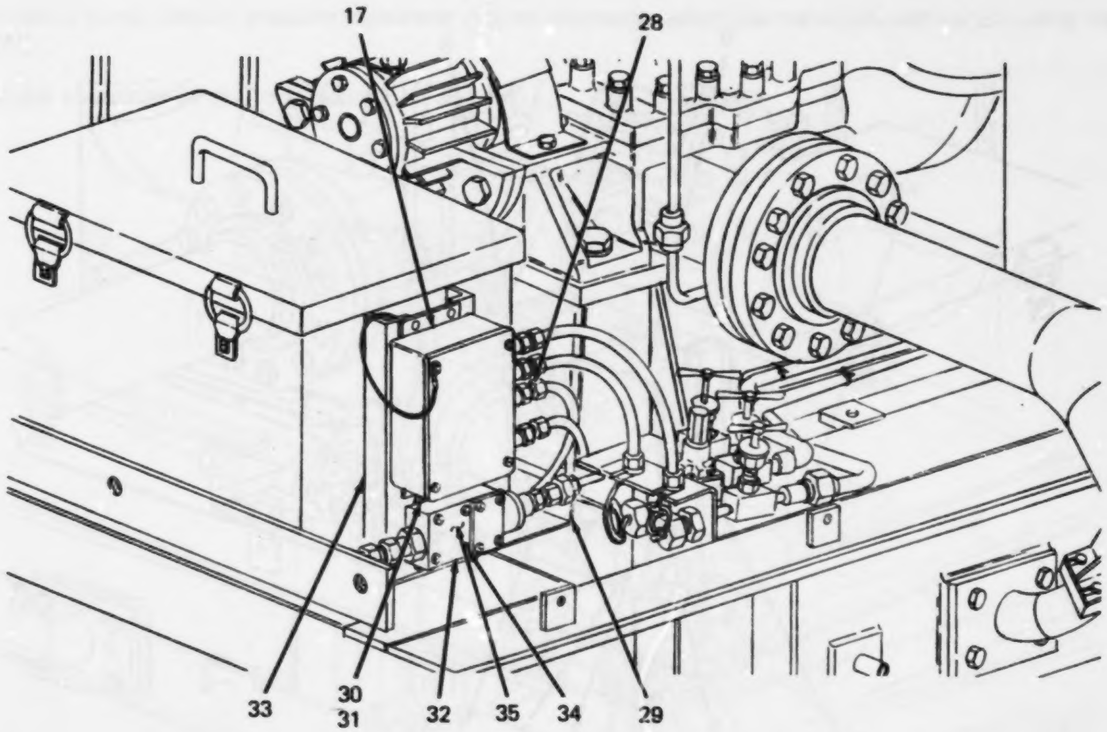
29 Disconnect coupling (29).

30 Remove four screws (30), lockwashers and nuts (31) securing box (32) to mounting (33) and remove box.

31 Separate connector, tag and desolder wires from connector.

32 Remove four screws (34) securing cover and gasket (35) to box (32).

33 Tag and remove wires from box (32).



TESTING/REPAIR/INSPECTION:

1 Test wires and cables for continuity and inspect for broken, burred, damaged, or frayed wiring.

2 Repair of components is limited to replacement of defective parts.

3 Inspect for loose or damaged connectors on wires and cables.

2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

INSTALLATION:

1 Install wires in box (1) and remove tags.

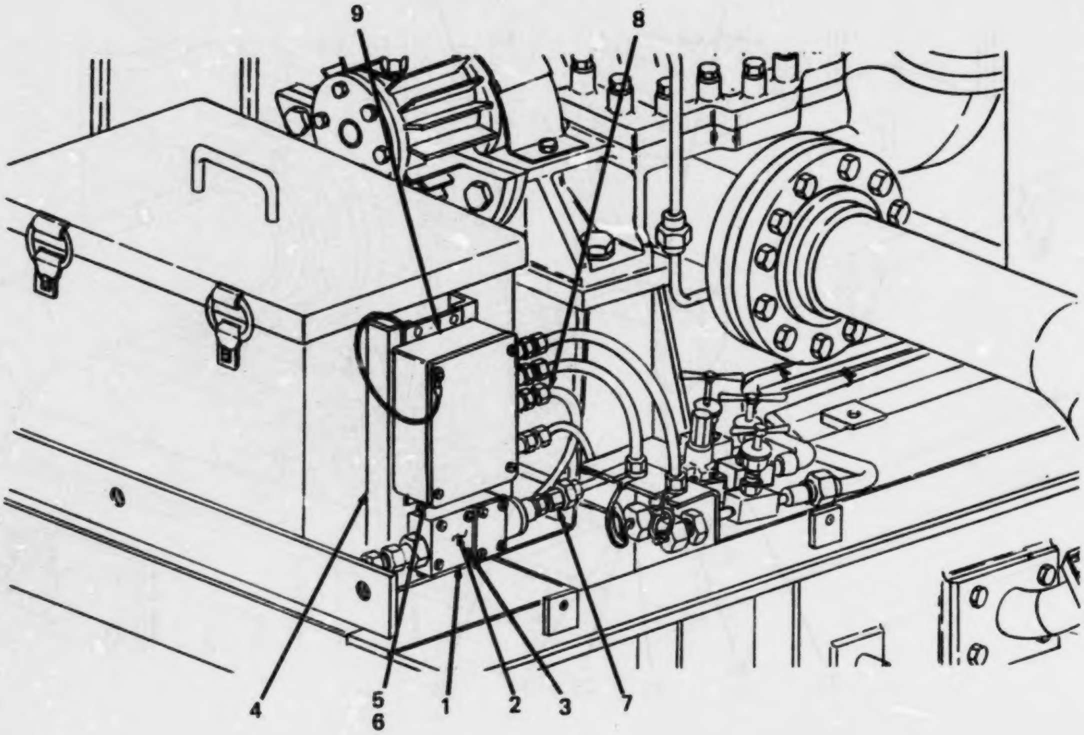
2 Position cover and gasket (2) on box (1) and secure using four screws (3).

3 Install pump suction pressure switch wiring in flexible conduit and solder wires to connector. Remove tags.

4 Position box (1) on mounting (4) and secure using four lockwashers (5), screws, and nuts (6).

5 Connect coupling (7) and tighten.

6 Install connector J3 (8) on junction box JB1 (9).



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

7 Install pump suction transmitter wiring in flexible conduit and solder wires to connector J2 (10). Remove tags.

8 Position cable to bracket (11) and secure using nut (12).

9 Position pump suction transmitter (13) on suction transducer valve (14) and secure using nut (15).

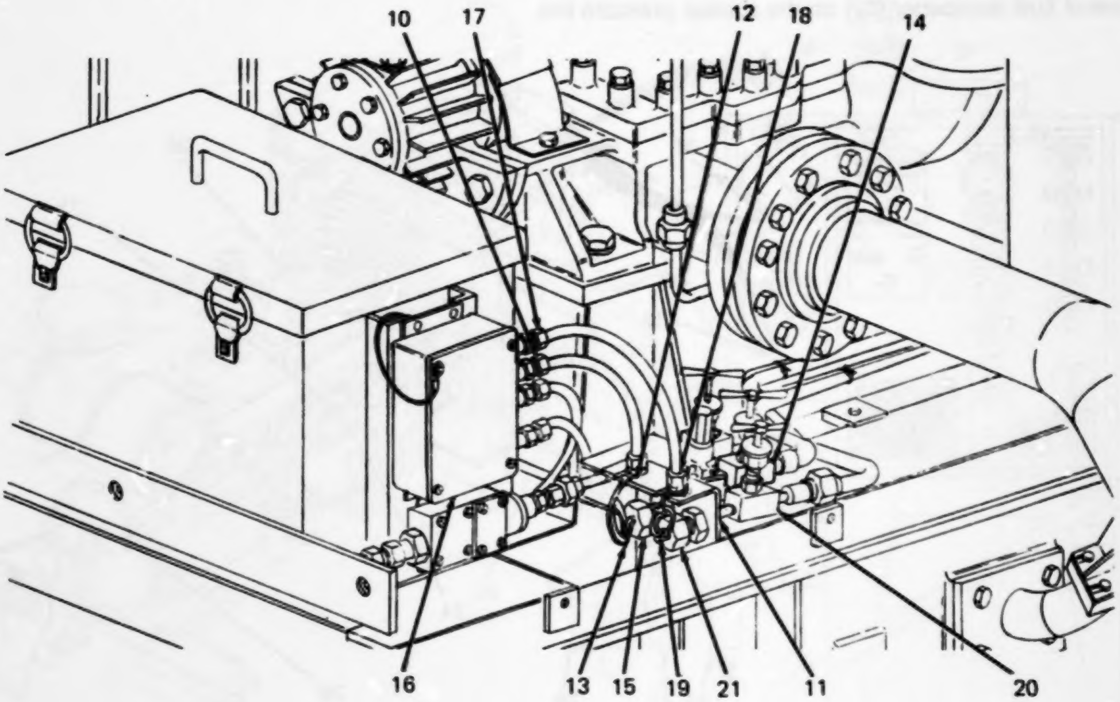
10 Install connector J2 (10) on junction box JB1 (16).

11 Install pump delivery pressure transmitter wiring in flexible conduit and solder wires to connector J1 (17). Remove tags.

12 Position cable to bracket (11) and secure using nut (18).

13 Position pump delivery pressure transmitter (19) on discharge transducer valve (20) and secure using nut (21).

14 Install connector J1 (17) on junction box JB1 (16).



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

15 Install wires on fuel solenoid valve (22). Remove tags.

16 Install wires on electronic fuel control actuator (23). Remove tags.

17 Position clutch limit switch (24) on control panel (25) and secure using four screws (26).

18 Connect wires to clutch limit switch (24). Remove tags.

19 Position clutch limit switch cover (27) on switch (24) and secure using two screws and washers (28).

20 Install magnetic pickup (29).

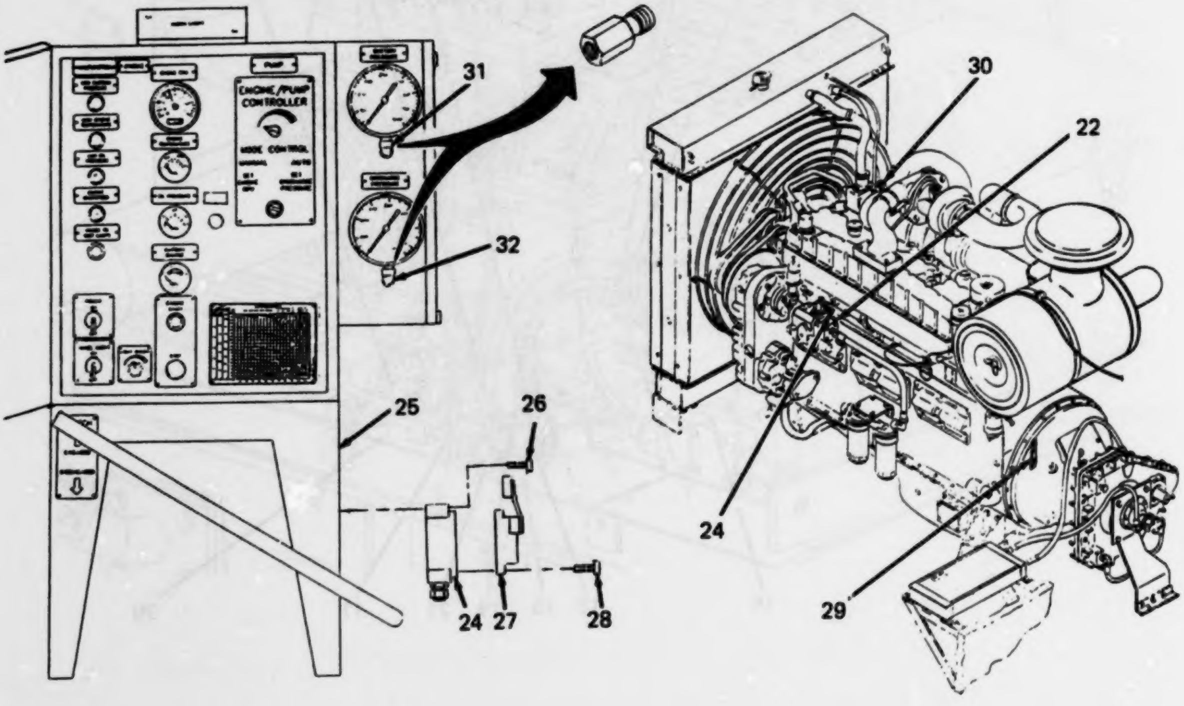
21 Install connector on magnetic pickup (29).

22 Install coolant temperature transmitter (30).

23 Install connector on coolant transmitter (30).

24 Install fluid dampener (31) on the discharge pressure line.

25 Install fluid dampener (32) on the suction pressure line.



2-30. FIELD INSTRUMENT LAYOUT TEST/REPAIR/REPLACE (CONT)

26 Install lube oil pressure transmitter (33).

27 Install connector on lube oil pressure transmitter (33).

28 Install high coolant temperature switch (34).

29 Install two wires on high coolant temperature switch (34). Remove tags.

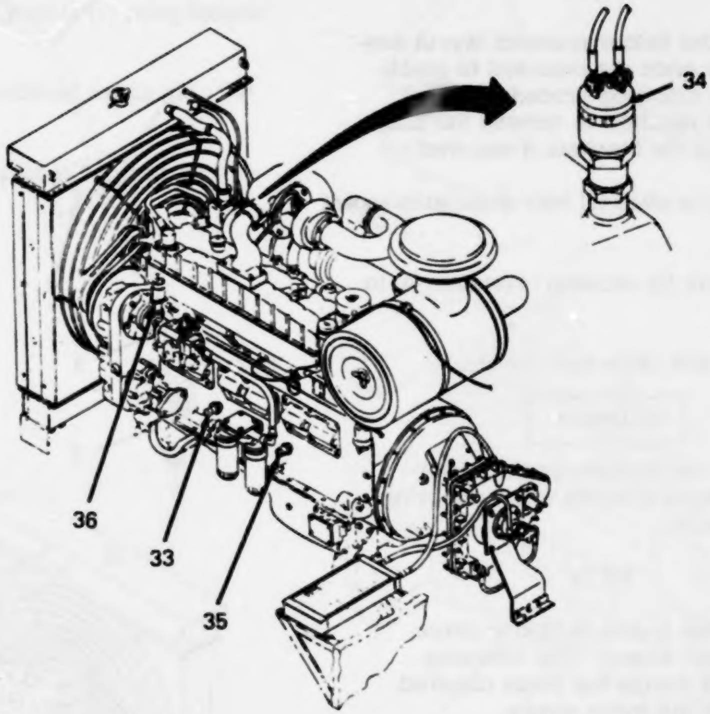
30 Install low oil pressure switch (35).

31 Install wires on low oil pressure switch (35). Remove tags.

32 Install speed sensor (36).

33 Install wire on speed sensor (36). Remove tags.

34 Connect battery cables in accordance with paragraph 2-27.



2-31. CONDUIT LAYOUT REPAIR/REPLACE

This task covers: a. Removal b. Repair/Inspection c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Nylon straps

Equipment Condition Reference	Condition Description
Paragraph 2-30	Field instrument layout removed

General Safety Instructions

Well ventilated area

REMOVAL:

NOTE

Most of the field instrument layout sensor cable ends are mounted to brackets. The following procedure detail the steps required to remove the cable ends from the brackets if required.

1 Tag and remove wires (1) from associated sensor (2).

2 Remove locknut (3) securing connector (4) to bracket (5).

3 Remove wire and cable from bracket.

CAUTION

Use care not to damage the underlying conduit or wires when removing nylon straps.

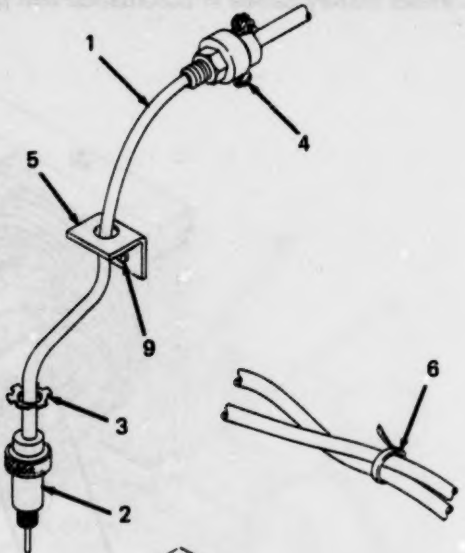
NOTE

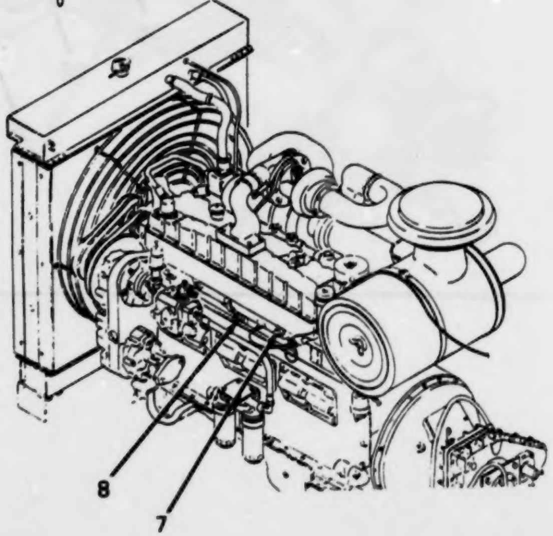
The conduit layout is held in place using nylon straps. The following procedure details the steps required to remove the nylon straps.

4 Using diagonal pliers, cut and remove associated nylon strap (6).

5 Remove five bolts (7), lockwashers, and spacers securing cable bracket (8) to engine.

6 Remove two bolts, lockwashers, and nuts securing two brackets to cable bracket (8).





2-31. CONDUIT LAYOUT REPAIR/REPLACE (CONT)

REPAIR/INSPECTION:

1 Repair is limited to replacement of damaged, rusted, or corroded components.

2 Inspect connectors for cracks, rust, corrosion and for damaged or stripped threads.

INSTALLATION:

1 Position two brackets (1) on cable bracket (2) and secure using two bolts, lockwashers, and nuts (3).

2 Position cable bracket (2) on engine and secure using five bolts, lockwashers, and spacers (4).

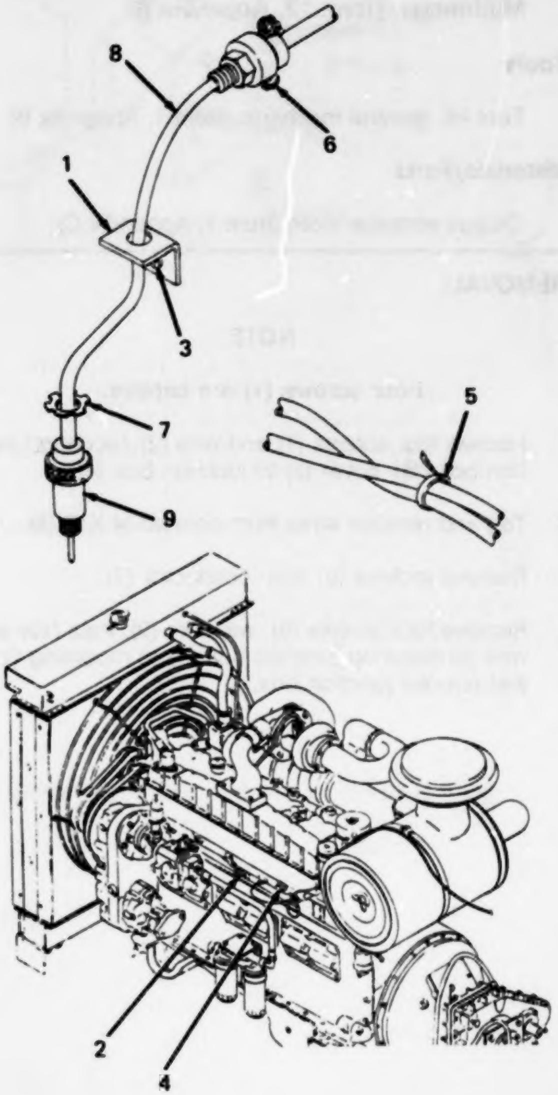
3 Secure conduit and associated wiring with nylon straps (5).

4 Position wire and cable in bracket (1).

5 Secure connector (6) in bracket (1) using locknut (7).

6 Connect wires (8) to associated sensor (9). Remove tags.

7 Install field instrument layout in accordance with paragraph 2-30.



2-32. JUNCTION BOX REPAIR/REPLACE

This task covers: a. Removal b. Repair c. Installation

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanic (Item 1, Appendix B)

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-30	Field instrument layout removed

General Safety Instructions

Well ventilated area

REMOVAL:

NOTE

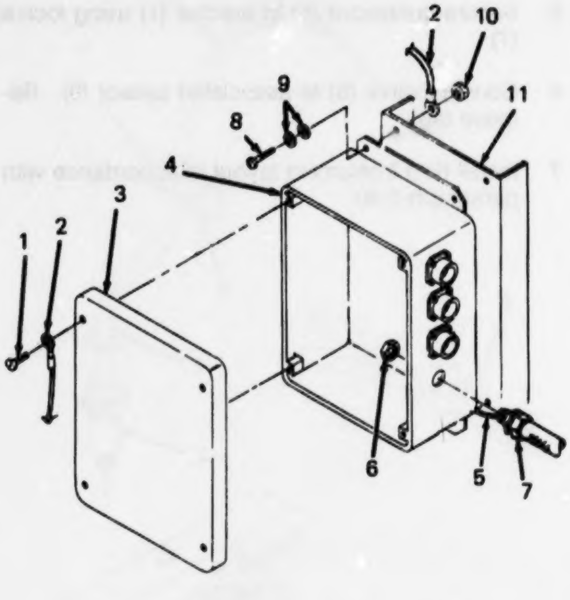
Four screws (1) are captive.

1 Loosen four screws (1) and wire (2) securing junction box JB1 cover (3) to junction box (4).

2 Tag and remove wires from connector X17 (5).

3 Remove locknut (6) from connector (7).

4 Remove four screws (8), washers (9), nuts (10) and wire (2) securing junction box (4) to mounting (11) and remove junction box.



2-32. JUNCTION BOX REPAIR/REPLACE (CONT)

NOTE

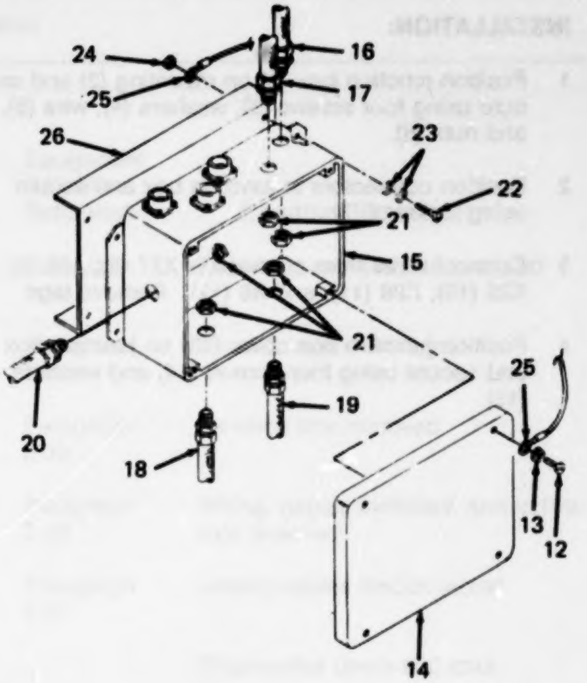
Four screws (12) are captive.

5 Loosen four screws (12) and washers (13) securing junction box JB2 cover (14) to junction box (15).

6 Tag and remove wires from connectors X6 (16), X28 (17), X25 (18), X26 (19), and X27 (20).

7 Remove locknuts (21) from connectors (16 thru 20) and remove connectors.

8 Remove four screws (22), washers (23), nuts (24), and wire (25) securing junction box (15) to mounting (26).



REPAIR:

1 Remove minor dents, rust, or corrosion on junction box and junction box cover. If severely damaged, dented, rusted, or corroded, replace.

2 Replace identification plates as necessary.

2-32. JUNCTION BOX REPAIR/REPLACE (CONT)

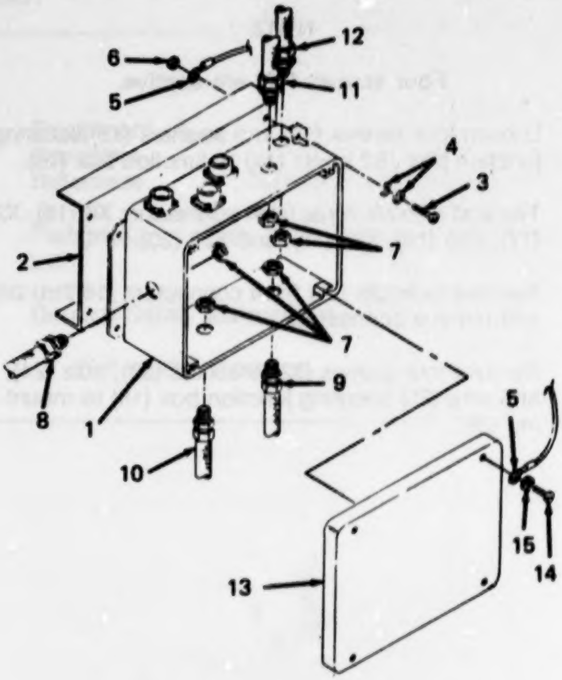
INSTALLATION:

1 Position junction box (1) on mounting (2) and secure using four screws (3), washers (4), wire (5), and nuts (6).

2 Position connectors in junction box and secure using locknuts (7).

3 Connect wires from connectors X27 (8), X26 (9), X25 (10), X28 (11), and X6 (12). Remove tags.

4 Position junction box cover (13) on junction box (1) and secure using four screws (14) and washers (15).



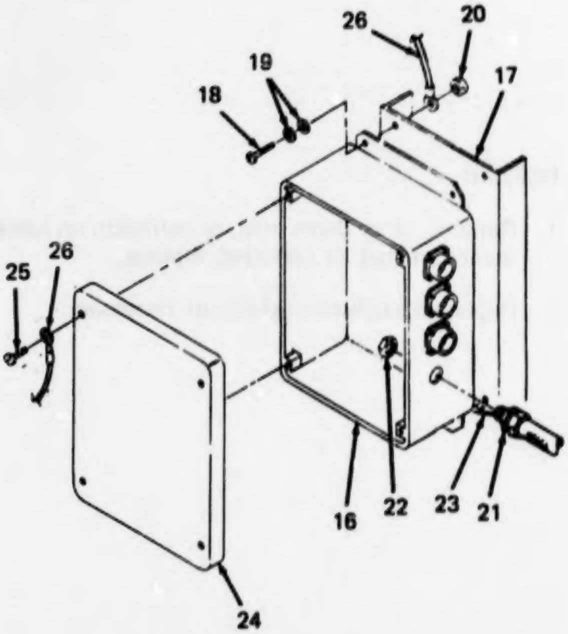
5 Position junction box JB1 (16) on mounting (17) and secure using four screws (18), washers (19), and nuts (20).

6 Position connector (21) in junction box JB1 (16) and secure using locknut (22).

7 Connect wires from X17 (23).

8 Position junction box JB1 cover (24) on junction box JB1 (16) and secure using four screws (25) and wire (26).

9 Install field instrument layout in accordance with paragraph 2-30.



2-33. NETWORK CABLE TEST/REPLACE

This task covers: a. Removal b. Testing c. Installation

INITIAL SETUP

Test Equipment

Multimeter (lem 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Nylon straps

Equipment Condition Reference	Condition Description
Paragraph 2-30	Field instrument layout removed
Paragraph 2-31	Conduit layout removed
Paragraph 2-32	Junction box removed
Paragraph 2-28	Wiring, gages, switches, and indicators removed
Paragraph 2-27	Battery cables disconnected
	Engine shut down and cool

General Safety Instructions

Well ventilated area

REMOVAL:

CAUTION

Use care not to damage the underlying cables or wires when removing nylon straps.

Removal of the network cables consists of cutting the nylon straps securing the cables being removed. Use diagonal pliers to reduce damage to underlying cables or wires.

TESTING:

Test wires and cables for continuity and inspect for broken, burred, damaged, or frayed wiring. Replace cables as required. Notify direct support maintenance if repairs to cables are required.

2-33. NETWORK CABLE TEST/REPLACE (CONT)

INSTALLATION:

1 Secure network cables using nylon straps in the appropriate location. Secure cables so that they are not loose or hanging.

2 Install battery cables in accordance with paragraph 2-27.

3 Install wiring gages, switches, and indicators in accordance with paragraph 2-28.

4 Install junction boxes in accordance with paragraph 2-32.

5 Install conduit layout in accordance with paragraph 2-31.

6 Install field instrument layout in accordance with paragraph 2-30.

2-34. SPEED INCREASER SERVICE/REPAIR

This task covers: a. Cleaning b. Servicing c. Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

General Safety Instructions

Well ventilated area

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Lubricating oil (Item 22, Appendix C)

Grease (Item 17, Appendix C)

CLEANING:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clotning. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Remove all oily dirt, grease, and diesel fuel from speed increaser drain with dry cleaning solvent and fill plugs, hoses, and heat exchanger assembly.

2 Dry all parts with compressed air.

2-34. SPEED INCREASER SERVICE/REPAIR (CONT)

SERVICING:

NOTE

Drain oil while warm.

Use speed increaser oil MIL-L-46167 Grade ARCTIC or MIL-L-2104 Grade 15W-40.

1 Drain oil as follows:

(a) Place a drain pan under oil drain plug (1) and loosen fillcap (2).

(b) Remove drain plug (1) and drain oil.

(c) Replace drain plug (1) and tighten.

2 Fill oil as follows:

(a) Remove oil fill plug (2).

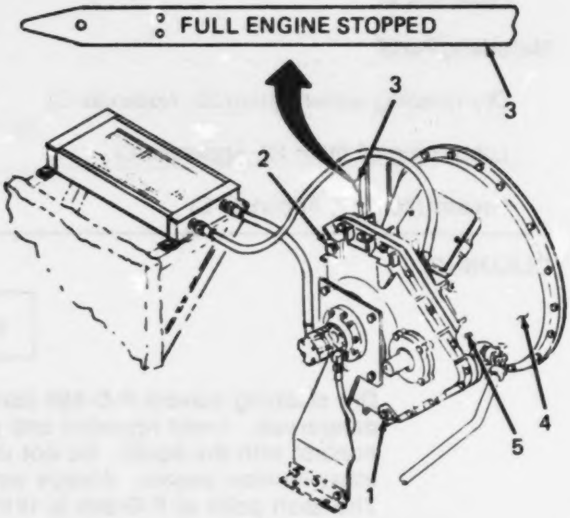
(b) Fill oil sump to full mark on dipstick (3).

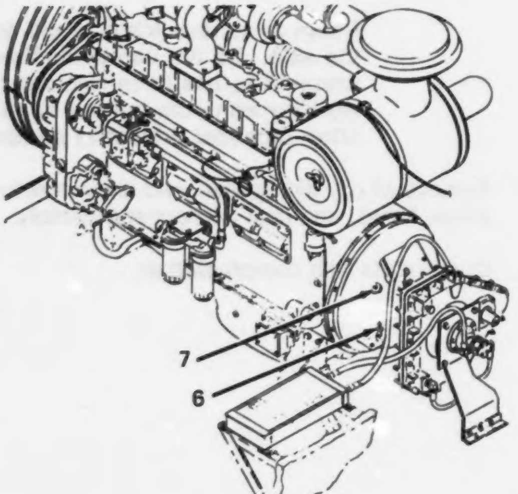
(c) Replace oil fill plug and tighten.

3 Lubricate speed increaser (4) pivots as follows:

(a) Grease speed increaser pivots (5 and 6) with one to two squirts of #2 lithium base grease.

(b) Grease speed increaser bearings (7) with one to two squirts of #2 lithium base grease.





2-34. SPEED INCREASER SERVICE/REPAIR (CONT)

REPAIR:

1 Remove heat exchanger as follows:

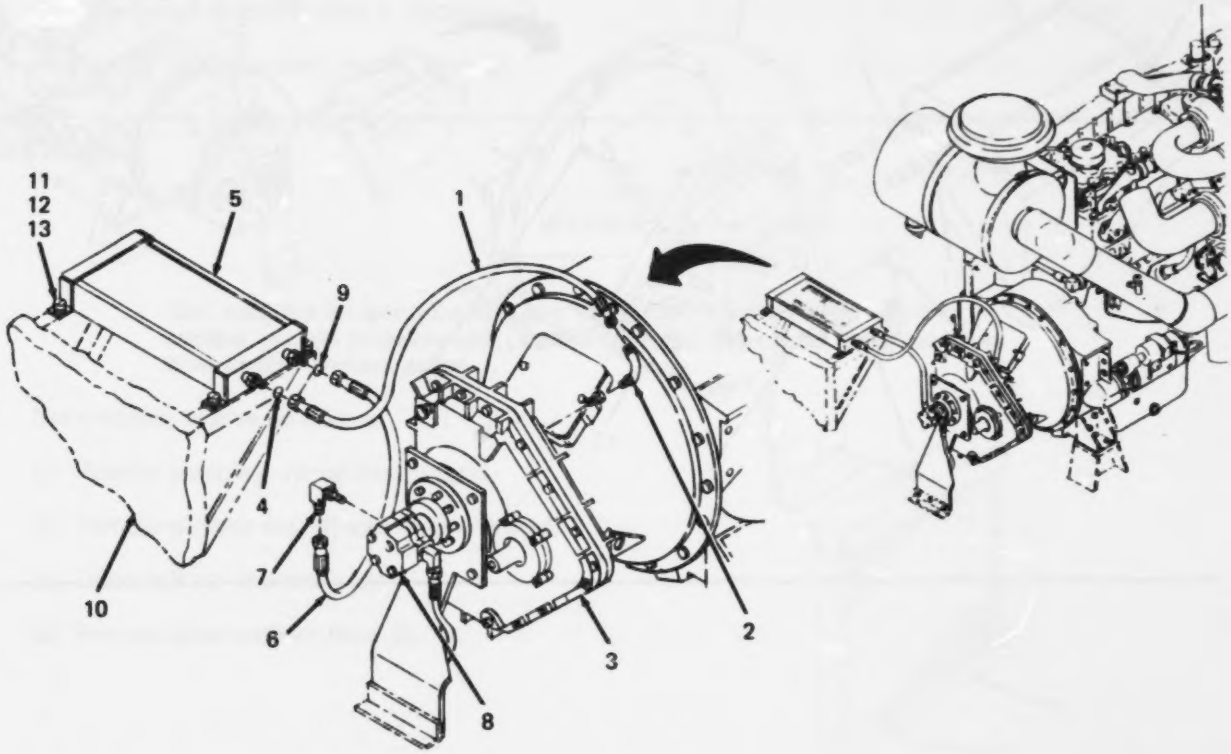
NOTE

Repair of the speed increaser for unit maintenance is limited to the replacement of the hoses and heat exchanger assembly. For further repair contact direct support maintenance.

(a) Remove one end of 24-inch long hose assembly (1) from 45° elbow (2) at housing assembly (3). Remove opposite end with O-ring (4) from heat exchanger (5).

(b) Remove one end of 24-inch long hose assembly (6) from 90° elbow (7) at fluid pump assembly (8). Remove opposite end with O-ring (9) from heat exchanger (5).

(c) Remove heat exchanger (5) from engine enclosure (10) by removing four bolts (11), washers (12), and nuts (13).



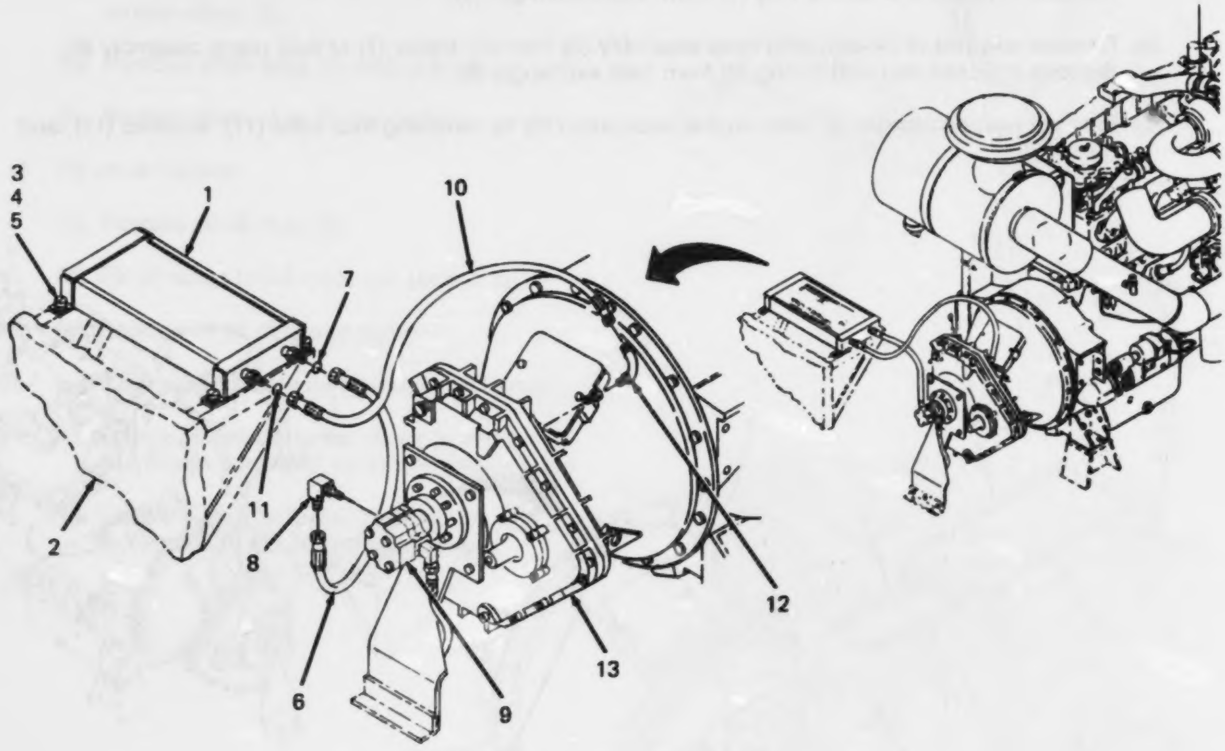
2-34. SPEED INCREASER SERVICE/REPAIR (CONT)

2 Install heat exchanger as follows:

(a) Install heat exchanger (1) on engine enclosure (2) using four bolts (3), washers (4), and nuts (5).

(b) Install end of 24-inch long hose assembly (6) with O-ring (7) to heat exchanger (1). Install opposite end to 90° elbow (8) to fluid pump assembly (9).

(c) Install end of 24-inch long hose assembly (10) with O-ring (11) to heat exchanger (1). Install opposite end to 45° elbow (12) to housing assembly (13).



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE

This task covers: a. Servicing b. Pressure Test c. Remove/Repair/Replace

INITIAL SETUP

Test Equipment

Pressure tester

DCA4 coolant test kit (Item 28, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable lifting device

Materials/Parts

Ethylene glycol antifreeze (Item 5, Appendix C)

Heavy duty cooling system cleaner (Item 25, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-23	Engine enclosure removed

General Safety Instructions

Ensure coolant temperature is below 120°F (50°C) before servicing the radiator assembly.

Well ventilated area

SERVICING:

WARNING

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

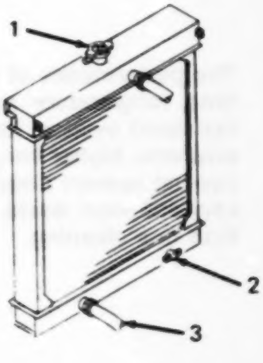
1 Drain cooling system as follows:

(a) Position pumping unit on level ground.

(b) Remove radiator cap (1) after engine is cool.

(c) Open radiator draincock (2).

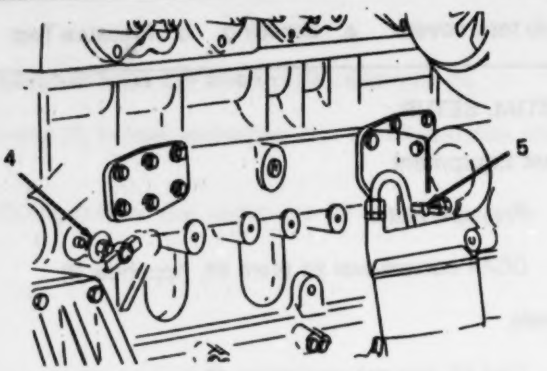
(d) Remove lower radiator hose (3).

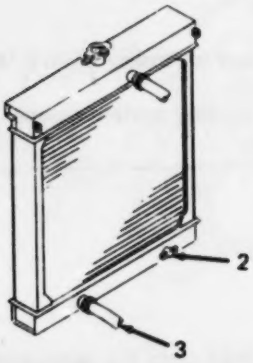


2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(e) Open engine draincock (4).

(f) Open oil cooler draincock (5).





(g) Close radiator draincock (2).

(h) Install lower radiator hose (3).

(i) Tighten hose clamps to 40 in-lbs torque (5 N·m).

(j) Close engine draincock (4).

(k) Close oil cooler draincock (5).

NOTE

Do not allow the cooling system to dry out.

Do not remove the coolant filter at this time.

2 Clean the cooling system (internally) as follows:

NOTE

The performance of heavy duty cooling system cleaner is dependent on time, temperature, and concentration levels. An extremely scaled or flow restricted system, for example, may require higher concentrations of cleaners, higher temperatures, or longer cleaning times. Heavy duty cooling system cleaner can be safely used up to twice the recommended concentration levels. Extremely scaled or fouled systems may require more than one cleaning.

2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

NOTE

Heavy duty cooling system cleaner contains no antifreeze. Do not allow the cooling system to freeze during the cleaning operation.

(a) Immediately add 1 gallon (3.8 litres) of heavy duty cooling system cleaner for each 10 to 15 gallons (38 to 57 litres) of cooling system capacity, and fill system with plain water.

(b) Operate engine at normal operating temperatures (at least 185°F (85°C)) for 1 to 1-1/2 hours.

(c) Shut engine off and drain cooling system in accordance with step 1.

(d) Fill cooling system with clean water.

(e) Operate engine at high idle for 5 minutes with the coolant temperature above 185°F (85°C).

(f) Shut engine off and drain cooling system.

NOTE

If the water being drained is still dirty, the system must be flushed again until the water is clean.

(g) Install a new coolant filter in accordance with paragraph 2-44.

3 Clean the cooling system (externally) as follows:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

(a) Steam clean outside of radiator.

2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

(b) Dry all parts with compressed air.

4 Refill the cooling system as follows:

NOTE

Ensure all draincocks are closed and hoses properly connected.

(a) Fill cooling system to bottom of fill neck in radiator fill tank with a fresh mixture of 50 percent ethylene glycol antifreeze and 50 percent water.

(b) Install pressure cap. Operate engine until it reaches a temperature of 180°F (80°C), and check for coolant leaks.

WARNING

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

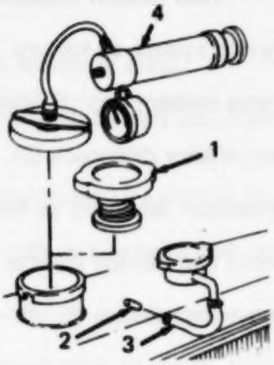
(c) Check coolant level and fill if necessary.

2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

PRESSURE TEST:

WARNING

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.



1 Remove radiator cap (1).

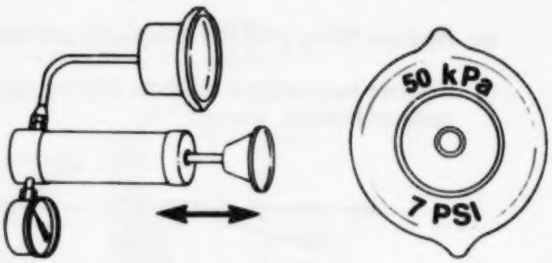
2 Check coolant level and fill if necessary.

3 Install plug (2) in overflow tube (3).

CAUTION

Do not apply more than 20 psi (140 kPa) air pressure to the cooling system. The water pump seal may be damaged.

4 Install pressure tester (4) on radiator fill neck and apply 20 psi (140 kPa) maximum air pressure.



5 Inspect for coolant leaks and repair if necessary.

6 Remove pressure test equipment and plug (2) from overflow tube (3).

NOTE

The pressure cap must seal within 2 psi (14 kPa) of the value stated on the cap, or it must be replaced.

7 Pressure test radiator cap.

8 Install radiator cap.

2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

REMOVE/REPAIR/REPLACE:

WARNING

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

1 Drain cooling system as follows:

(a) Remove radiator cap (1) after the engine is cool.

(b) Open radiator draincock (2).

2 Remove radiator assembly as follows:

(a) Remove two clamps (3) and remove lower return hose (4).

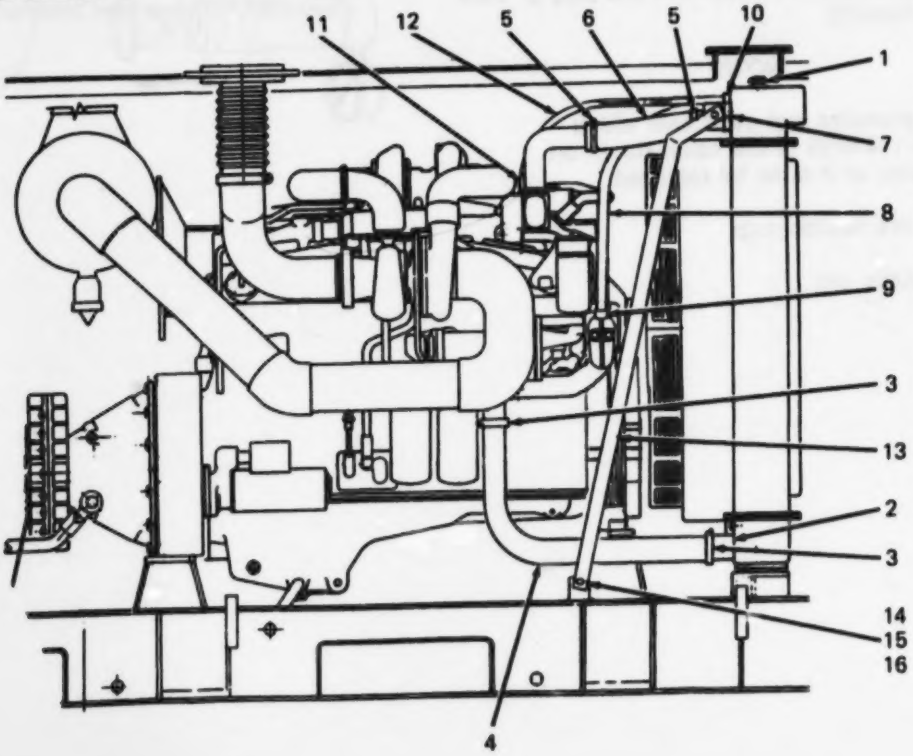
(b) Remove two clamps (5) and remove upper supply hose (6).

(c) Remove clamp (7) from makeup hose (8).

(d) Remove fitting (9) and remove makeup hose (8).

(e) Remove fitting (10) and fitting (11) and remove vent hose (12).

(f) Remove two radiator brackets (13) by removing two screws (14), washers (15), and nuts (16) from each radiator bracket.



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(g) Remove eight screws, lockwashers, and washers (17) securing fan guard (18) to shroud top (19).

(h) Remove four mounting screws (20), nuts (21), and washers (22).

WARNING

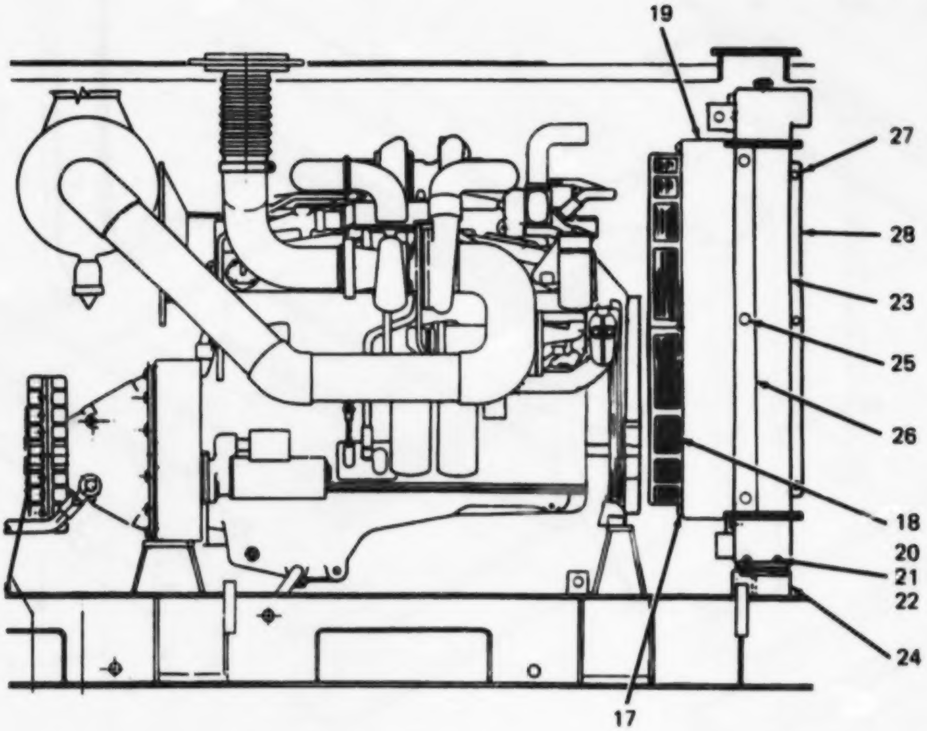
Radiator weighs 501 lbs (227 kg). Use suitable lifting device to prevent injury to personnel.

(i) Using suitable lifting device, remove radiator assembly (23) from skid assembly (24).

(j) Remove six screws, lockwashers, washers, and three radiator overflow hose clamps (25) from shroud frame (26) and remove from radiator assembly (23).

(k) Remove overflow hose from radiator cap overflow tube and pull through clamp on shroud top (19).

(l) Remove six screws, lockwashers, and washers (27) from core guard (28) and remove from radiator assembly (23).



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(m) Remove 62 screws (29), lockwashers (30), and nuts (31).

(n) Remove tank bottom (32), gasket (33), and header bars (34) from radiator core (35).

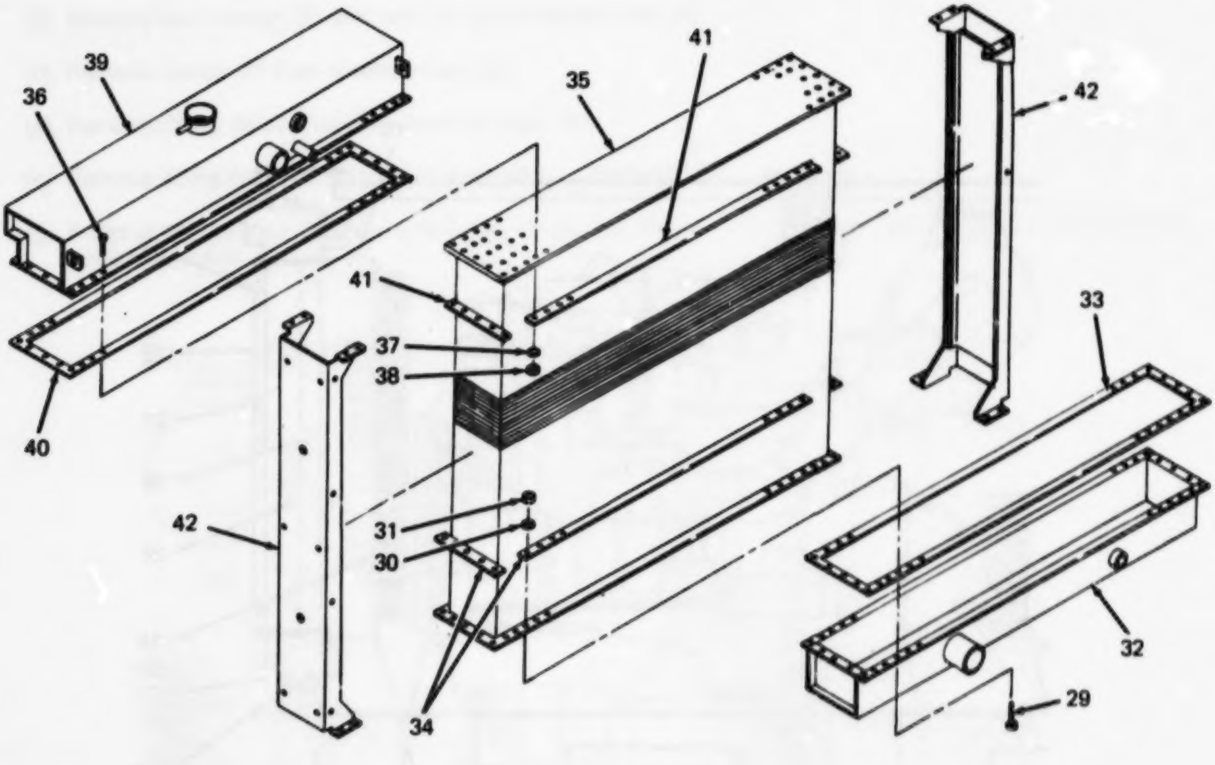
(o) Remove 62 screws (36), lockwashers (37), and nuts (38).

(p) Remove tank top (39), gasket (40), and header bars (41).

(q) Remove two side members (42) from radiator core (35).

NOTE

Repair of the radiator assembly is limited to the replacement of parts. For radiator core soldering and servicing notify direct support maintenance.



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

3 Replace radiator assembly as follows:

(a) Place tank bottom (31) on a clean flat surface.

(b) Place gasket (32) on tank bottom flange.

(c) Position radiator core (34) on top of gasket (32) and tank bottom flange.

(d) Place header bars (33) in position on radiator core (34) flange. Align holes.

(e) Position two side members (41) on top of header bars (33) and align all holes.

(f) Insert 62 screws (28), lockwashers (29), and nuts (30). Do not tighten at this time. Loosely install only.

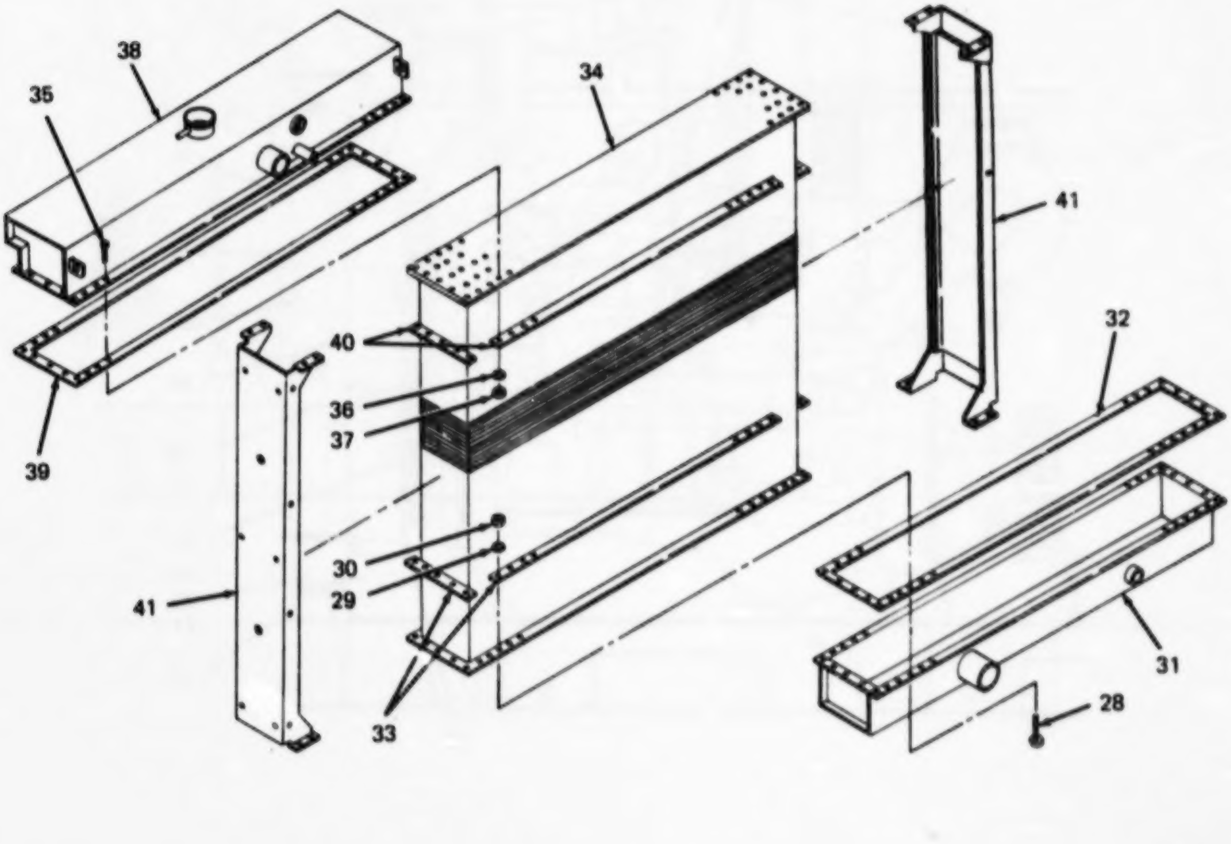
(g) Place gasket (39) on upper surface flange of radiator core (34).

(h) Position tank top (38) on top of gasket (39).

(i) Install header bars (40) to underside of core flange. Align all holes.

(j) Insert 62 screws (35), lockwashers (36), and nuts (37).

(k) Tighten all screws and nuts.



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(l) Place core guard (27) in position on radiator assembly (22).

(m) Align holes and insert and tighten six screws, lockwashers, and washers (26).

(n) Place shroud frame (25) in position on radiator assembly (22).

(o) Pull overflow hose through clamp on shroud top and secure to radiator cap overflow tube.

(p) Align holes and insert and tighten six screws, lockwashers, washers, and three radiator overflow hose clamps (24).

WARNING

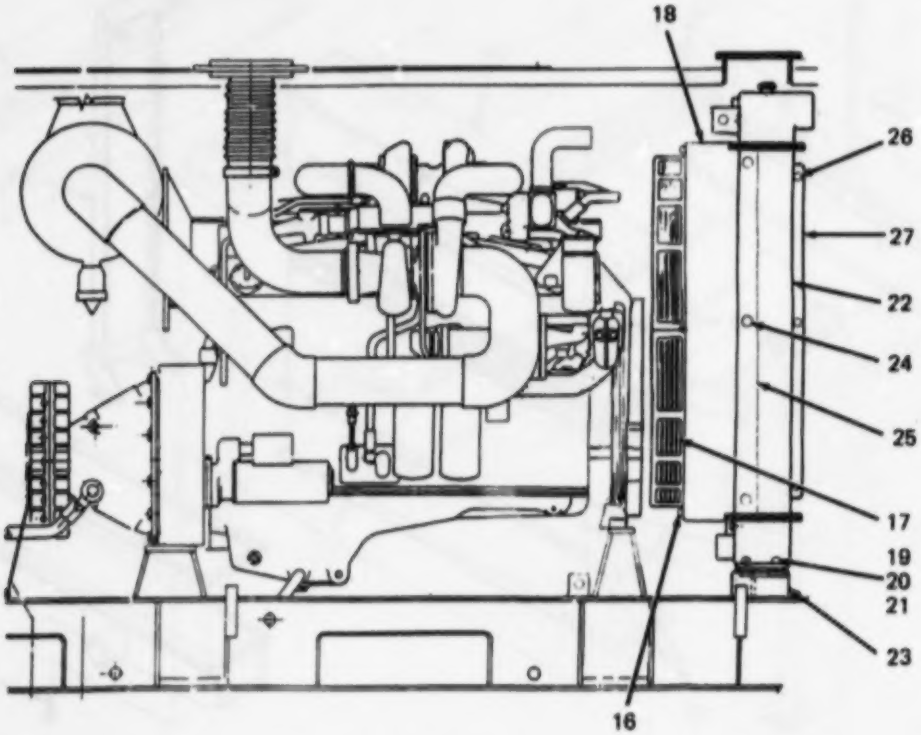
Radiator weighs 501 lbs (227 kg). Use suitable lifting device to prevent injury to personnel.

(q) Install radiator assembly (22) on skid assembly (23).

(r) Align holes and insert four mounting screws (19), four nuts (20), and washers (21).

(s) Place fan guard (17) on shroud top (18).

(t) Align holes, insert and tighten eight screws, lockwashers, and washers (16).



2-35. RADIATOR ASSEMBLY SERVICE/TEST/REPAIR/REPLACE (CONT)

(u) Position two radiator brackets (12) against skid and radiator assembly.

(v) Align holes and insert and tighten two screws (13), two washers (14), and nuts (15) for each radiator bracket.

(w) Install vent hose (11) by connecting fitting (9) and fitting (10).

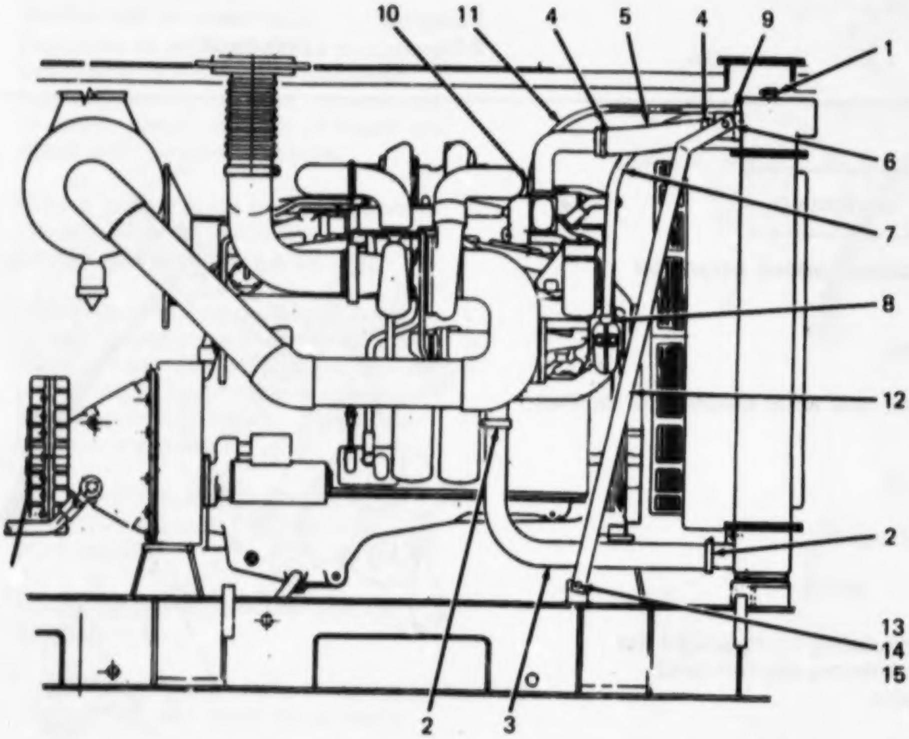
(x) Install makeup hose (7) and connect fitting (8) and clamp (6).

(y) Install upper supply hose (5) and fasten with two clamps (4).

(z) Install lower return hose (3) and fasten with two clamps (2).

(aa) Ensure all draincocks are closed and fill system in accordance with step 4 of Servicing task.

(ab) Install engine enclosure in accordance with paragraph 2-23.



2-36. ENGINE SERVICE

This task covers: Servicing

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Lubricating oil (Item 22, Appendix C)

Suitable drain pan

Cloth

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area required during operational check.

Equipment Condition Reference	Condition Description
Paragraph 2-52	Lubrication oil filter service performed

SERVICING:

WARNING

Hot oil can cause serious personnel injury.

1 Drain oil as follows:

(a) Operate engine until water temperature reaches 140°F (60°C).

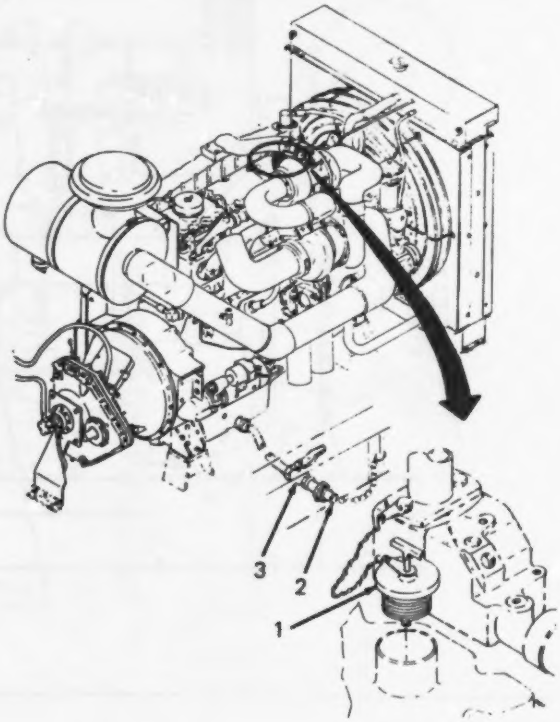
(b) Shut engine off.

(c) Remove oil fill cap (1).

NOTE

Drain oil immediately to insure all the oil and contaminants are removed from the engine.

(d) Place drain pan under oil drain plug (2).



(e) Remove plug (2) from outlet side of drain valve (3).

(f) Turn drain valve (3) to open position.

(g) Turn drain valve (3) to closed position when all oil is drained.

(h) Replace plug (2) into outlet side of drain valve (3).

2-36. ENGINE SERVICE (CONT)

2 Replace oil as follows:

(a) Remove lubricating oil dipstick (4) and wipe with clean rag.

(b) Add specified amount of clean 15W-40 oil through oil fill fitting (5).

(c) Check oil level on dipstick (4). Oil must be up to the H (high) mark.

(d) Replace oil fill cap (1).

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

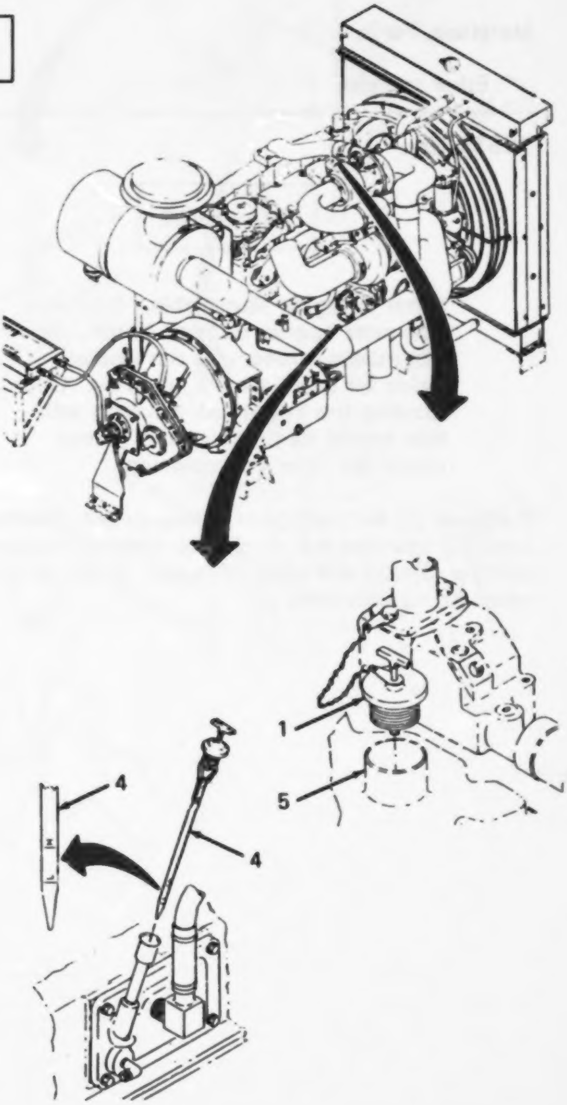
GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

(e) Start engine in accordance with TM 5-4320-307-10.

(f) Operate engine until water temperature reaches 180°F (80°C) and check for oil leaks.

(g) Shut engine off. Wait 5 to 7 minutes for oil to drain back to oil pan.

(h) Check oil level. Add oil as necessary to bring level up to the H (high) mark on dipstick (4).



2-37. COLD STARTING AID ASSEMBLY REPLACE

This task covers: a. Testing b. Inspection c. Removal d. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Ether cylinder

General Safety Instructions

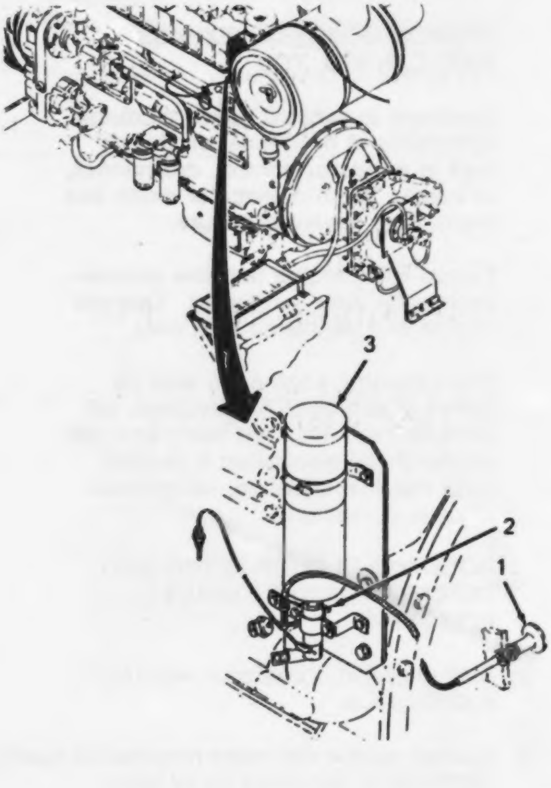
Well ventilated area

TESTING:

WARNING

Ether is highly flammable. Do not use near sparks or open flame. Do not inhale fumes. Do not operate valve for more than 3 seconds. Overloading the engine air housing with this highly flammable fluid (ether) could result in an explosion.

Pull knob (1) for 3 seconds or less to test operation. If valve (2) operates but no ether is released, replace cylinder (3) and test valve (2) again. If still no ether is released, replace valve (2).



2-37. COLD STARTING AID ASSEMBLY REPLACE (CONT)

INSPECTION:

1 Inspect hose for cracks or other damage. Replace if damaged.

2 Inspect valve, cylinder, adapter, hose connector, and atomizer for heavy corrosion, dents, or damaged threads. Replace if damaged.

REMOVAL:

1 Loosen thumbscrew (1) to release clamp (2) from ether cylinder (3).

2 Remove ether cylinder (3) by unscrewing from valve (4). Remove gasket (5).

3 Unscrew hose connector (6) from atomizer (7) and remove atomizer (7) from air intake (8).

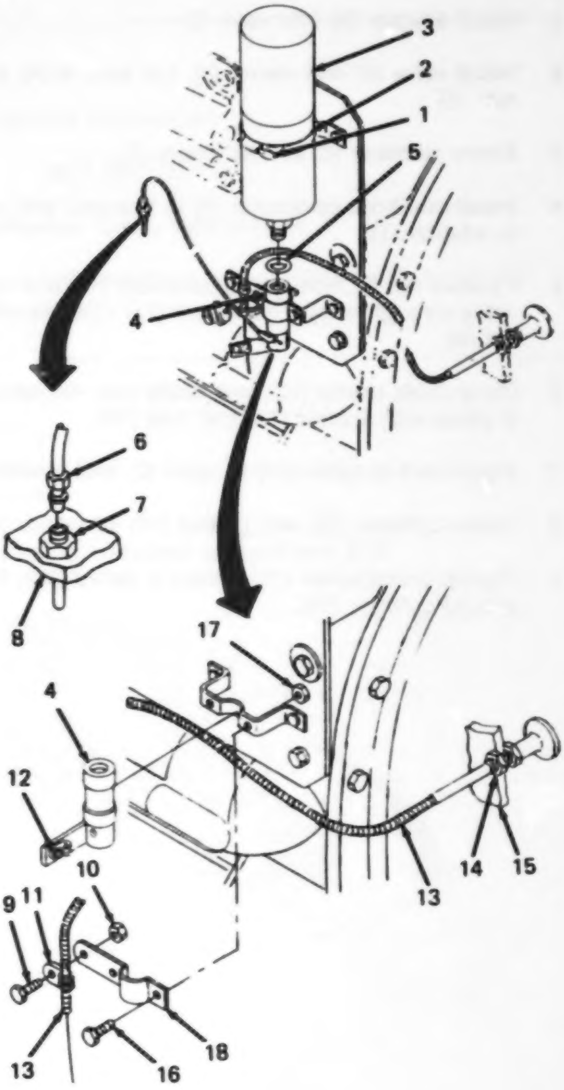
4 Loosen screw (9) and nut (10) securing clamp (11).

5 Loosen screw (12) securing cable (13) to valve (4).

6 Loosen and remove nut (14) securing cable (13) to engine enclosure (15).

7 Remove cable (13) from engine enclosure (15).

8 Remove two screws (16), nuts (17), and clamp (18) securing valve (4) and remove valve.



2-37. COLD STARTING AID ASSEMBLY REPLACE (CONT)

INSTALLATION:

1 Install adapter (1) into valve (2).

2 Install valve (2) with clamp (3), two screws (4), and nuts (5).

3 Screw atomizer (6) into air intake (7).

4 Install one hose connector (8) to atomizer and one to adapter (1).

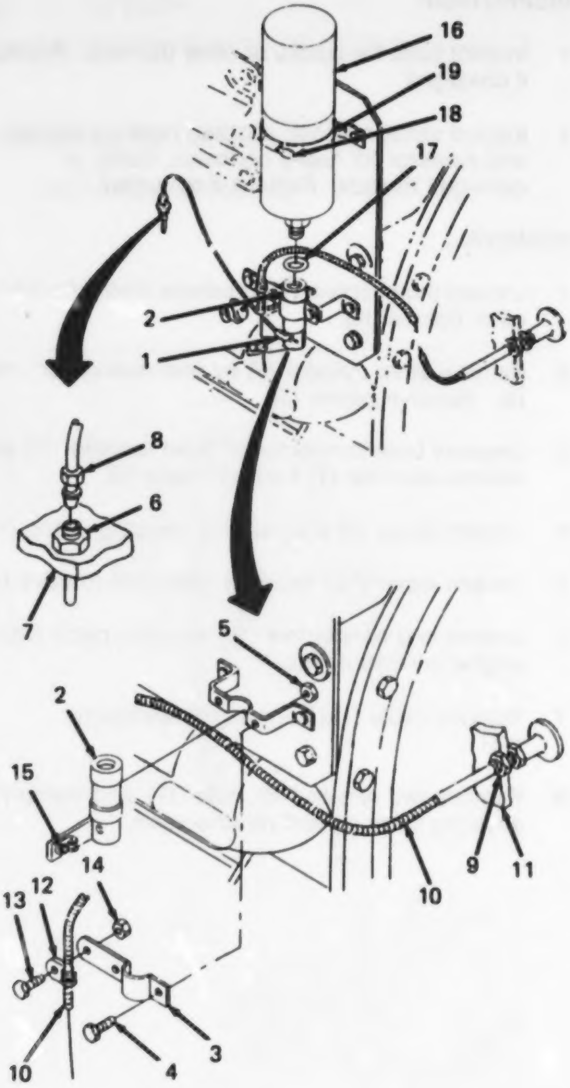
5 Remove nut (9) from cable assembly (10) and insert cable through engine enclosure (11). Secure with nut (9).

6 Place cable clamp (12) over cable (10) and secure in place with screws (13) and nuts (14).

7 Attach end of cable (10) to valve (2) with screw (15).

8 Screw cylinder (16) with gasket (17) into valve (2).

9 Tighten thumbscrew (18) securing clamp (19) around cylinder (16).



2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE

This task covers: a. Service b. Removal c. Inspection d. Repair e. Installation
f. Operational Check

INITIAL SETUP:

Tools

Tool kit, general mechanics

Materials/Parts

Soft cloth

Crocus abrasive cloth (Item 1, Appendix C)

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area required for cleaning and testing.

SERVICE:

WARNING

NBC contaminated filters must be handled using adequate precautions (FM 21-40) and must be disposed of by trained personnel.

1 Remove primary and secondary elements as follows:

(a) Loosen wing nut (1).

(b) Remove and discard primary element (2).

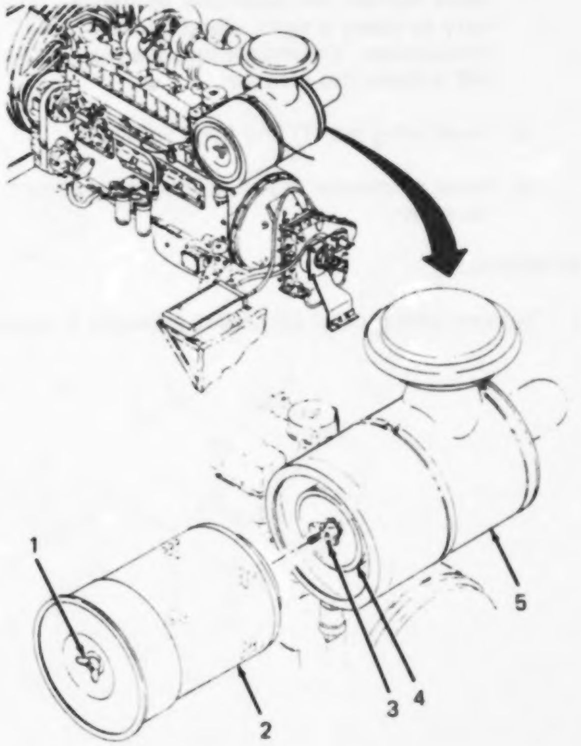
(c) Remove cotter pin and nut (3) from threaded rod.

(d) Remove and discard secondary element (4) as required.

CAUTION

Do not operate engine without an air cleaner element. Failure to comply with this instruction will result in internal engine component damage.

(e) Wipe interior of body assembly (5) with clean, dry cloth.



2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

2 Install primary and secondary elements as follows:

(a) Install secondary element (4) into body assembly. Align hole in element with threaded rod.

CAUTION

Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening the nut will deform the element.

(b) Install nut (3), hand tighten, and install cotter pin.

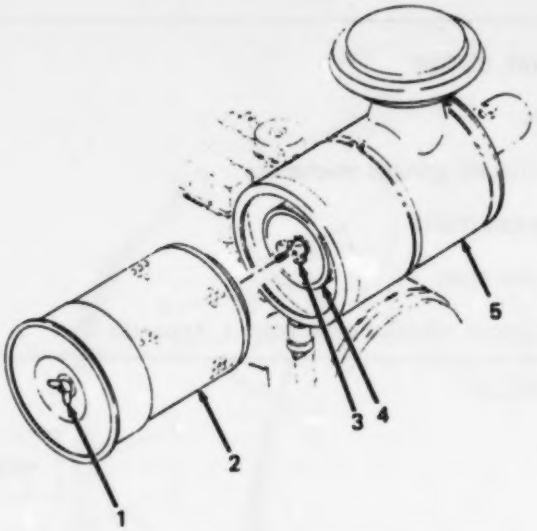
(c) Install primary element (2) over secondary element (4). Align hole in element with threaded rod.

CAUTION

Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening the nut will deform the element.

(d) Install wing nut (1) and hand tighten.

(e) Reset air cleaner intake restriction indicator if necessary.



REMOVAL:

1 Remove primary and secondary elements in accordance with step 1 of Service task.

2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

2 Loosen clamp (1) on air cleaner cap (2) and remove from air cleaner (3).

3 Loosen clamps (4 and 5) and remove hose elbow (6).

4 Loosen clamp (7) and remove air inlet tube (8).

5 Loosen clamp (9) and remove hose elbow (10).

6 Loosen clamp (11), slide off tube brace (12), and remove air tube (13).

7 Remove two screws (14) and lockwashers (15), and remove tube brace (12) from engine.

8 Loosen clamp (16) and remove hose elbow (17).

9 Unscrew restriction indicator (18) from air inlet tube (19).

10 Loosen clamp (20) and remove air inlet tube (19).

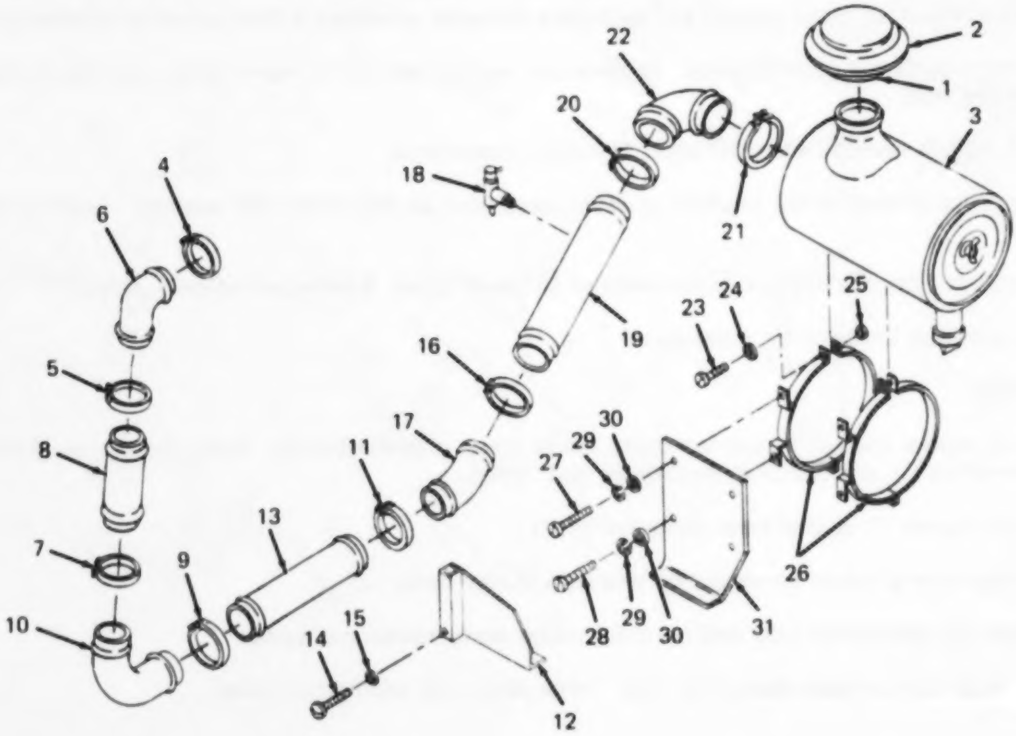
11 Loosen clamp (21) and remove hose elbow (22).

12 Remove screw (23), lockwasher (24), and nut (25) from each of the two air cleaner straps (26).

13 Remove air cleaner (3).

14 Remove two screws (27 and 28), two lockwashers (29), and two plain washers (30).

15 Remove air cleaner bracket (31) and two clamp halves (26).



2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

INSPECTION:

NOTE

Replace air filter elements if air cleaner restriction indicator signal indicates replacement or if service interval is due.

1 Inspect air cleaner body assembly, cup assembly, baffle assembly, rain cap, restriction indicator, and clamps for damage, dents, holes, rust, or corrosion. Replace if severely damaged or rusted.

2 Inspect rubber elbows, reducer, and adapter. Replace if brittle, cracked, or deteriorated. Inspect pipe and clamps for damage, dents, rust, or corrosion. Replace if severely damaged or rusted.

3 Check that the restriction indicator, set under vacuum, is readable and can be reset. Replace if damaged or if it does not function.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

REPAIR:

1 Using compressed air, clean primary and secondary elements, or replace if they cannot be cleaned properly.

2 Repair minor dents and abraded areas. Remove rust, or corrosion on air cleaner body, rain cap, or clamps with abrasive cloth.

3 Repair or replace severely worn, damaged, or rusted components.

4 Do not attempt to repair brittle, cracked, or deteriorated hose elbows, tubes, and adapters. Replace as necessary.

5 Using abrasive cloth, remove rust or corrosion on air intake tubes. If damaged severely, replace.

6 Replace restriction indicator if it is damaged.

INSTALLATION:

1 Position air cleaner bracket (1) and two clamp halves (2) on engine assembly. Insert two screws (3 and 4), two lockwashers (5), and two plain washers (6) and tighten.

2 Position air cleaner (7) against inner clamp halves (2).

3 Position outer clamp halves (8) against air cleaner and align holes.

4 Insert screw (9), lockwasher (10), and nut (11) through clamp halves and tighten.

5 Position clamp (12) on hose elbow (13). Install hose elbow (13) and tighten clamp.

2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

6 Position clamp (14) on air inlet tube (15). Install air inlet tube (15) on hose elbow (13) and tighten clamp.

7 Install restriction indicator (16) into air inlet tube (15).

8 Position clamp (17) on hose elbow (18).

9 Position tube brace (19) against engine. Insert two screws (20) and lockwashers (21), and tighten.

10 Position clamp (22) on air tube (23). Install air tube (23) on hose elbow (18) and tighten clamp.

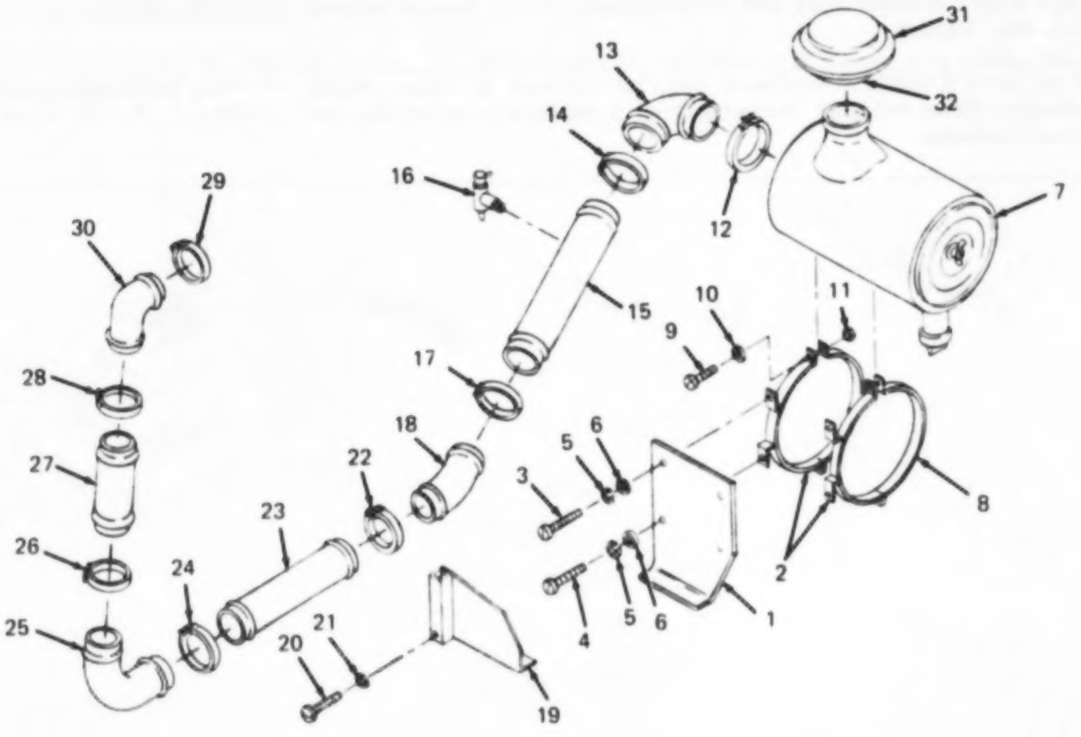
11 Position clamp (24) on hose elbow (25). Install hose elbow (25) on air tube (23) and tighten clamp.

12 Position clamp (26) on air inlet tube (27). Install air inlet tube (27) on hose elbow (25) and tighten clamp.

13 Position clamps (28 and 29) on hose elbow (30). Install hose elbow (30) to turbocharger inlet.

14 Position air cleaner cap (31) on air cleaner (7) and tighten clamp (32).

15 Install primary and secondary elements in accordance with step 2 of Service task.



2-38. AIR CLEANER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10 and observe installed components for looseness, rattles, or leaks. Tighten.

2 If red band is visible in window of restriction indicator, shut down engine. Recheck installation and element(s). Reset indicator. Restart engine. If red band is still visible, replace indicator. Restart engine and check indicator.

2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE

This task covers: a. Removal b. Repair c. Installation d. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Gaskets

Lockwashers

Manual References

TM 5-4320-307-10

General Safety Instructions

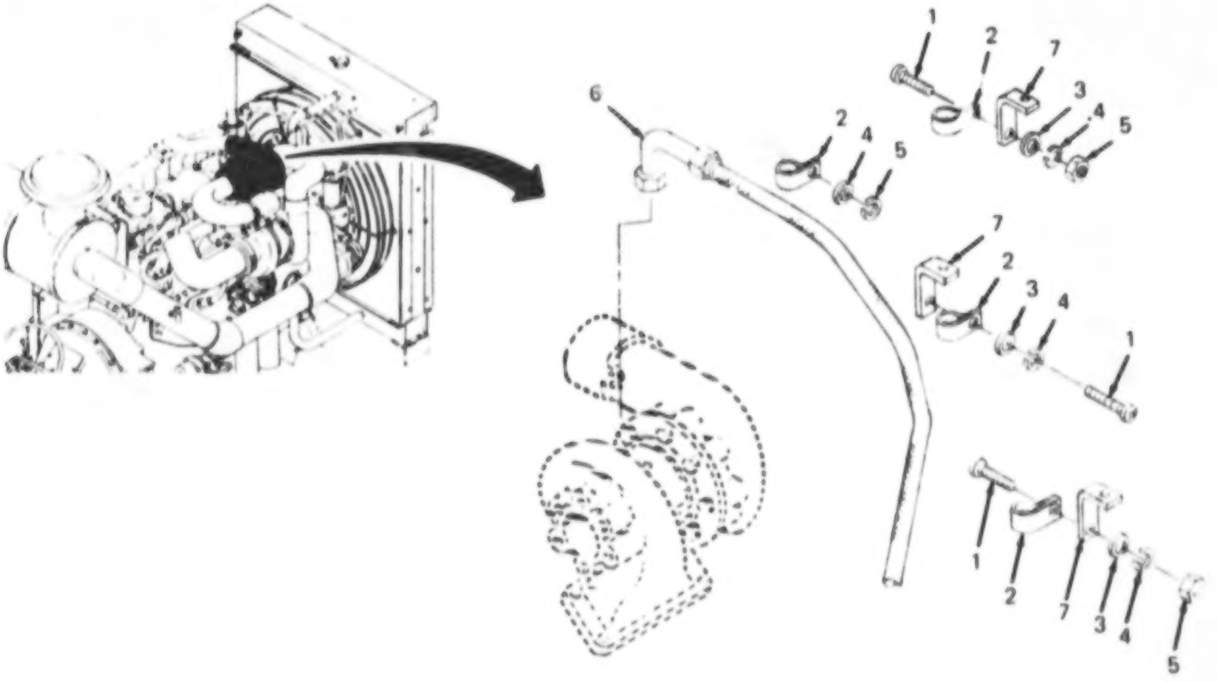
Well ventilated area

REMOVAL:

WARNING

Handling hot exhaust system can cause severe burns. Allow unit to cool before handling.

1 Remove four screws (1), clips (2), washers (3), lockwashers (4), and three nuts (5) securing flexible hose (6) to braces (7).



2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE (CONT)

2 Unscrew and remove ends of flexible hose (6) and remove hose.

3 Remove connector (8).

4 Remove two capscrews and lockwashers (9) securing flange (10) and gasket (11) to turbocharger (12).

5 Remove elbow (13) from pipe adapter (14).

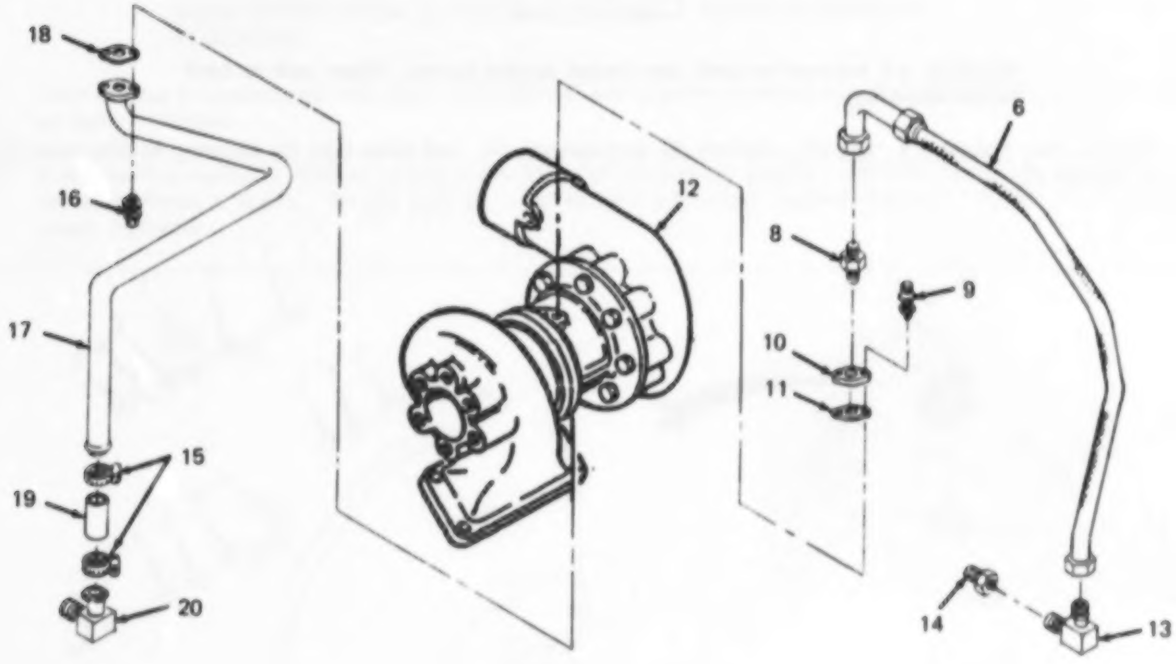
6 Remove pipe adapter (14) from engine.

7 Loosen clamps (15).

8 Remove screws and lockwashers (16) securing oil drain tube (17) and gasket (18) to turbocharger (12).

9 Remove oil drain tube (17), gasket (18), clamps (15), and hose (19) from elbow (20).

10 Remove elbow (20).



11 Remove screw and lockwasher (21), washer (22), clip (23), and tube brace (24) securing flexible hose (25) to engine.

12 Unscrew ends of flexible hose (25) and remove hose (25).

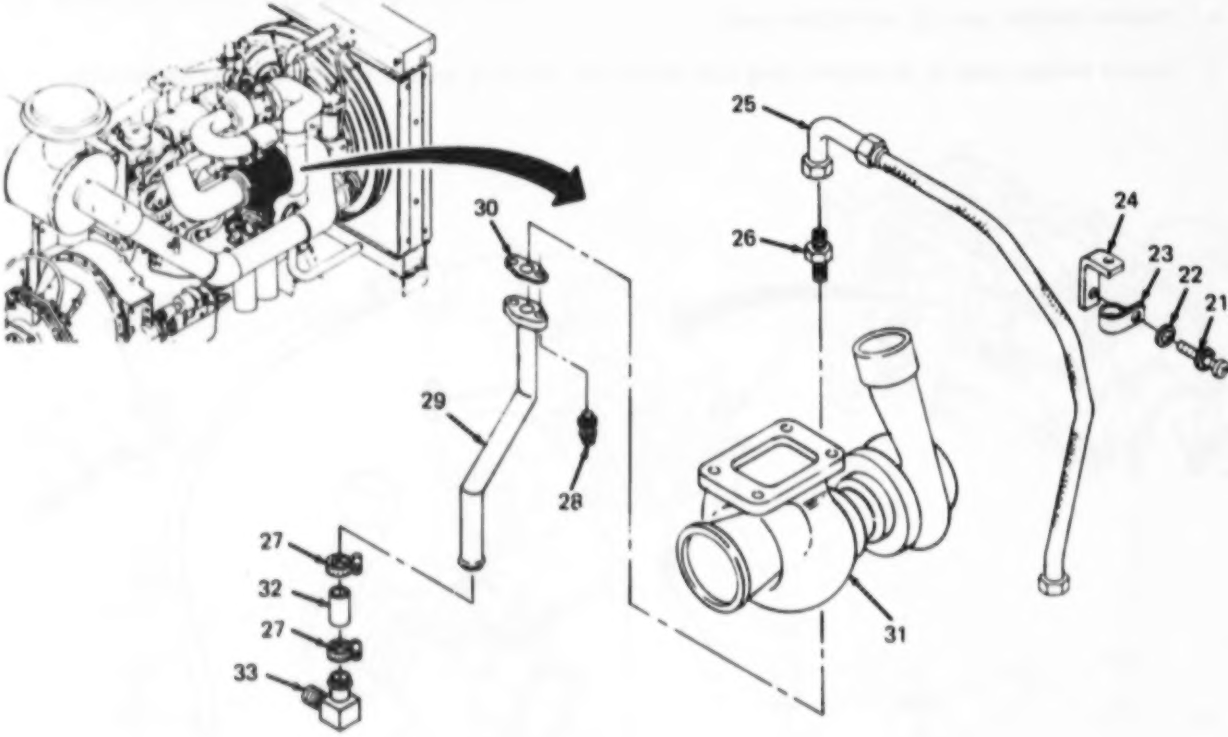
13 Remove connector (26).

14 Loosen clamps (27).

15 Remove screws and lockwashers (28) securing oil drain tube (29) and gasket (30) to turbocharger (31).

16 Remove oil drain tube (29), gasket (30), clamps (27), and hose (32) from elbow (33).

17 Remove elbow (33).



2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE (CONT)

REPAIR:

Repair of turbocharger plumbing and oil feed lines is limited to replacement of damaged or worn parts. If further maintenance is required, notify direct support maintenance.

INSTALLATION:

1 Install elbow (1).

2 Install hose (2), clamps (3), oil drain tube (4), and gasket (5) on elbow (1).

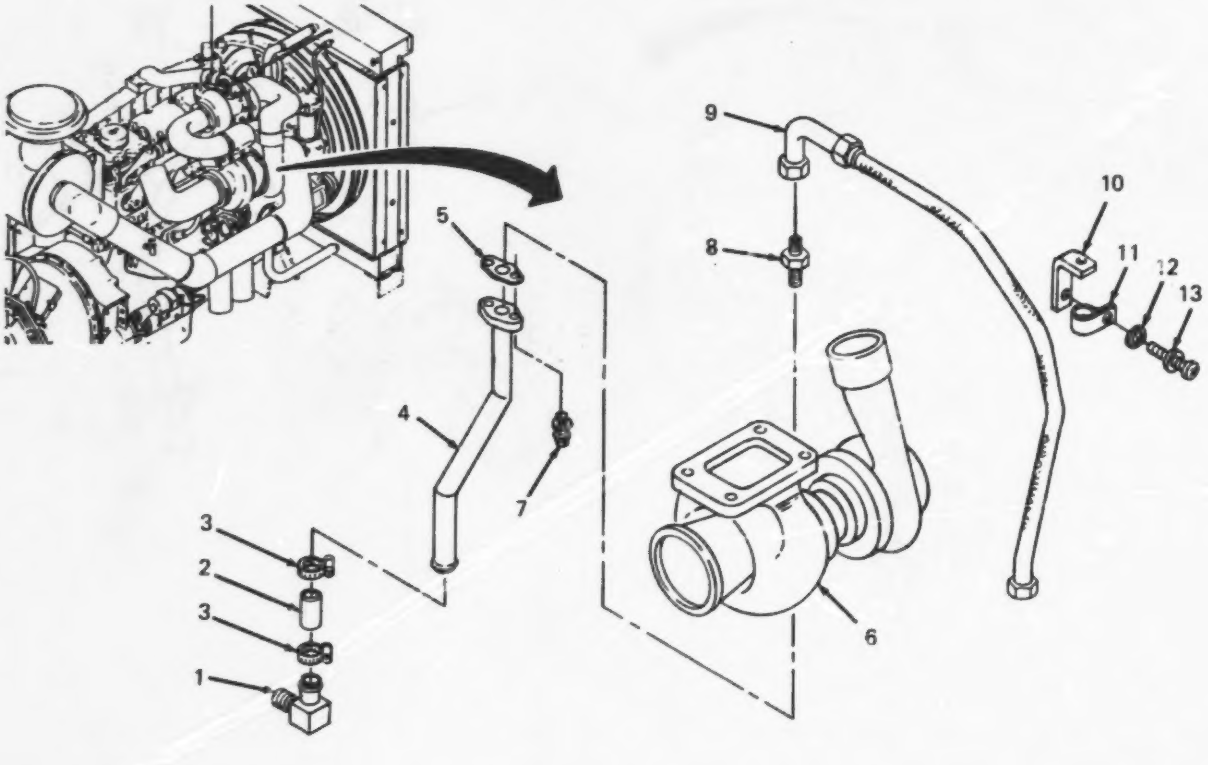
3 Position oil drain tube (4) and gasket (5) on turbocharger (6) and secure using two screws and lockwashers (7).

4 Tighten clamps (3).

5 Install connector (8).

6 Position flexible hose (9) and tighten ends.

7 Secure flexible hose (9) to engine using tube brace (10), clip (11), washer (12), screw, and washer (13).



2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE (CONT)

8 Install elbow (14).

9 Install hose (15), clamps (16), oil drain tube (17), and gasket (18) on elbow (14).

10 Position oil drain tube (17) and gasket (18) on turbocharger (19) and secure using screws and lockwashers (20).

11 Tighten clamps (16).

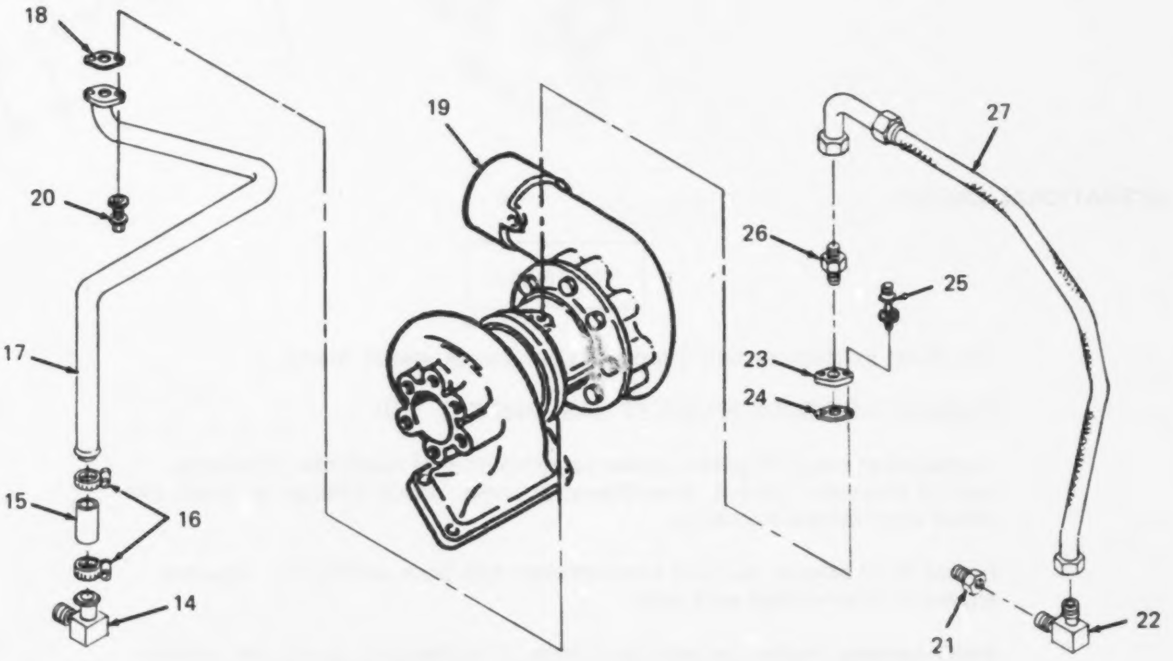
12 Install pipe adapter (21) in engine.

13 Install elbow (22) in pipe adapter (21).

14 Position flange (23) and gasket (24) on turbocharger (19) and secure using two capscrews and lockwashers (25).

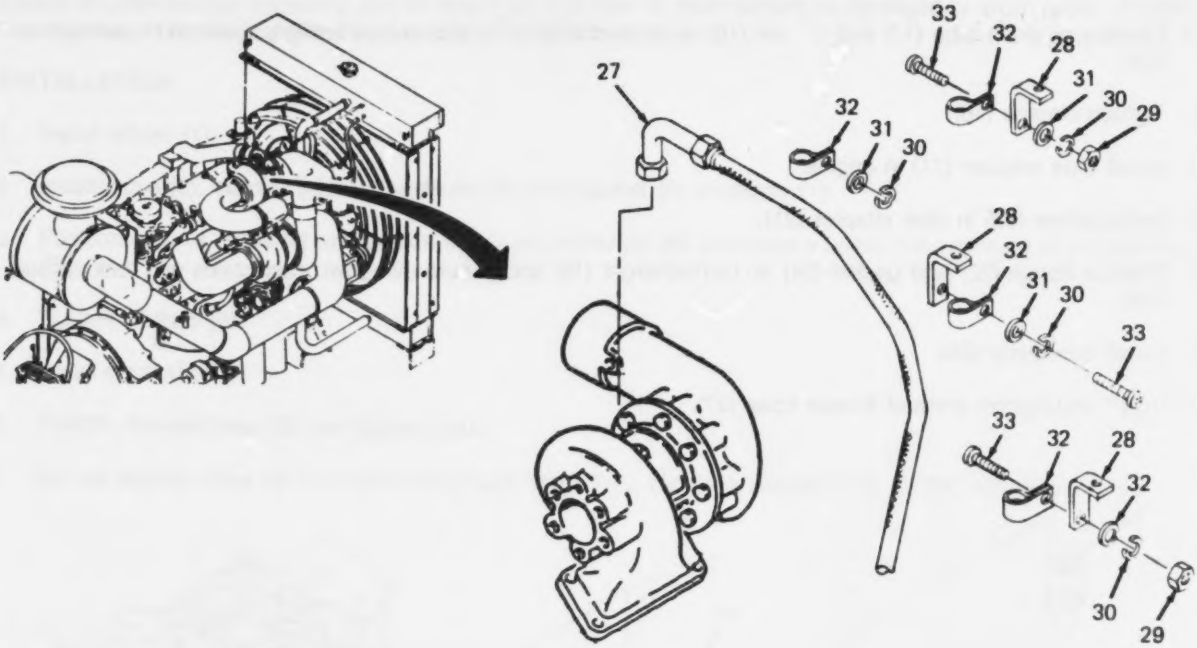
15 Install connector (26).

16 Install and tighten ends of flexible hose (27).



2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE (CONT)

17 Position flexible hose (27) on braces (28) and secure using three nuts (29), four lockwashers (30), washers (31), clips (32), and screws (33).



OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

2-39. TURBOCHARGER PLUMBING REPAIR/REPLACE (CONT)

1 Start engine in accordance with TM 5-4320-307-10 and check for loose, rattling components. Tighten as necessary to prevent rattles.

2 Check for oil leaks around lube oil line connections to the turbocharger and oil return lines. Tighten connections as necessary.

2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE

This task covers: a. Removal b. Inspection/Repair c. Installation d. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Gaskets

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-38	Air intake elbow removed
Paragraph 2-39	Turbocharger plumbing and oil feed lines removed

General Safety Instructions

Well ventilated area

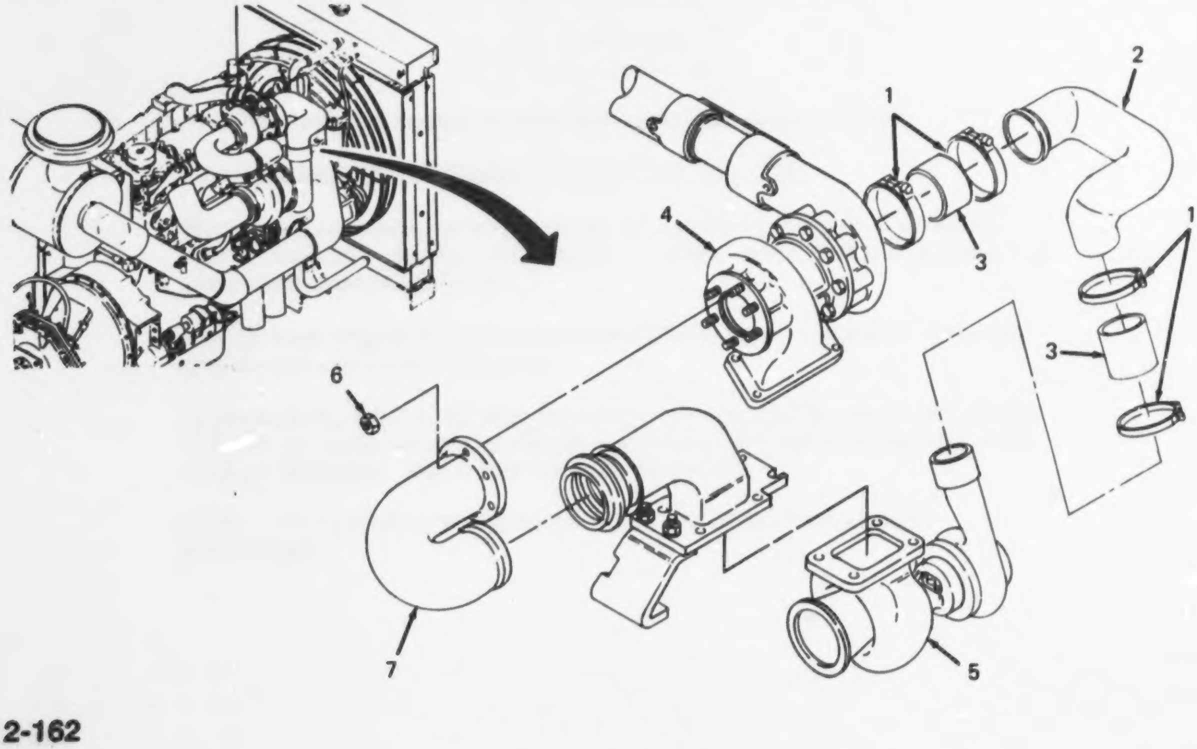
REMOVAL:

NOTE

The following procedure will remove both turbochargers.

1 Loosen T-bolt clamps (1) securing air inlet pipe (2) and hose (3) to turbochargers (4 and 5). Remove air inlet pipe (2), hose (3), and T-bolt clamps (1).

2 Remove six nuts (6) securing exhaust outlet connection (7) to turbocharger (4).



2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

3 Loosen V-band clamp (8) securing exhaust outlet connection (7) to exhaust outlet connection (9) and remove V-band clamp (8), and exhaust outlet connection (7).

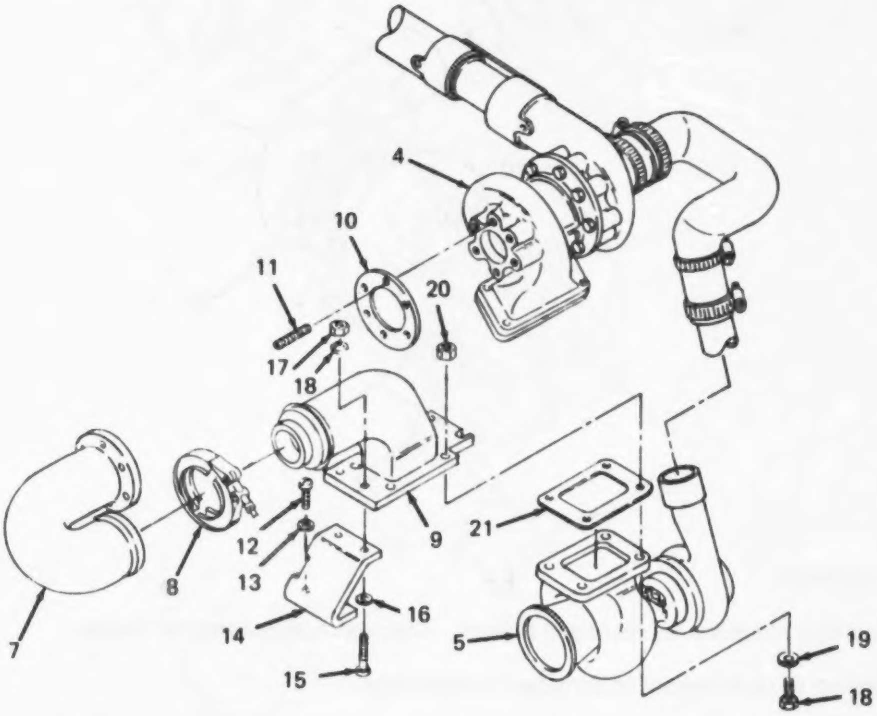
4 Remove turbocharger gasket (10).

5 Remove studs (11) (if required) from turbocharger (4).

6 Remove two screws (12) and washers (13) securing two braces (14) to engine.

7 Remove two screws (15), washers (16), and nuts (17) securing brace (14) to exhaust outlet connection (9) and remove brace (14).

8 Remove four screws (18), washers (19), nuts (20), and turbocharger gasket (21) securing exhaust outlet connection (9) to turbocharger (5) and remove exhaust outlet connection (9).



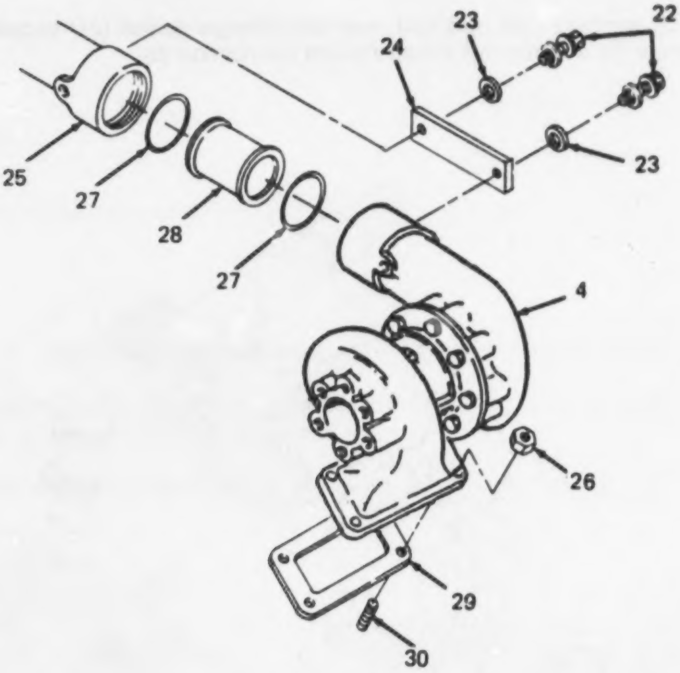
2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

9 Remove two screws (22), lockwashers, washers (23), and two turbocharger straps (24) securing turbocharger (4) to air cross-over connection (25).

10 Remove four nuts (26) securing two turbochargers (4) to exhaust manifold.

11 Remove turbocharger (4), O-ring seals (27), air inlet pipe (28), and turbocharger gasket (29).

12 Remove studs (30) (if required) from exhaust manifold.



INSPECTION/REPAIR:

1 Inspect mounting hardware for damaged threads. Check all components for cracks.

2 Repair is limited to replacement of damaged components.

NOTE

If any further turbocharger maintenance is required, forward turbochargers to direct support maintenance.

2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

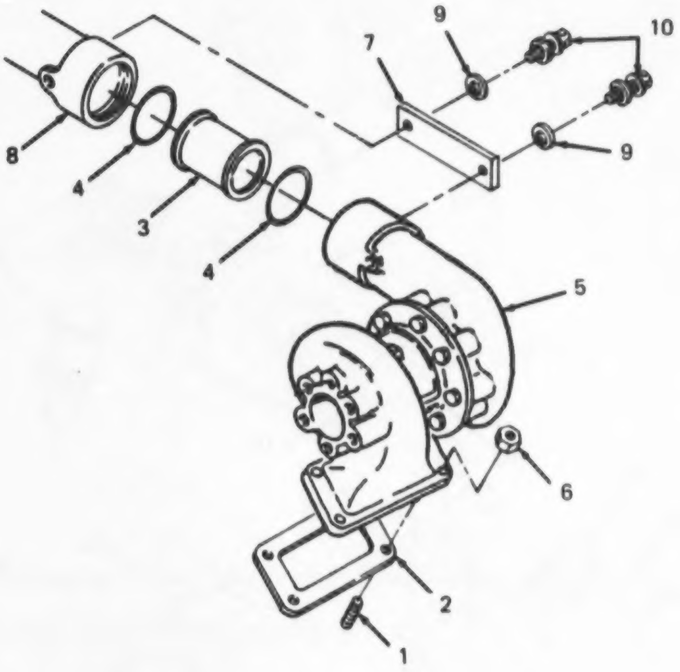
INSTALLATION:

1 Install studs (1) (If required) on exhaust manifold.

2 Position turbocharger gasket (2), air inlet pipe (3), O-ring seals (4), and turbocharger (5).

3 Install four nuts (6) securing turbocharger (5) to exhaust manifold.

4 Position two turbocharger straps (7) and secure to turbocharger (5) and air crossover connection (8) using two washers (9), and lockwashers and screws (10).



2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

5 Position exhaust outlet connection (11) on turbocharger (5) and secure using turbocharger gasket (12), nu (13), washers (14), and four screws (15).

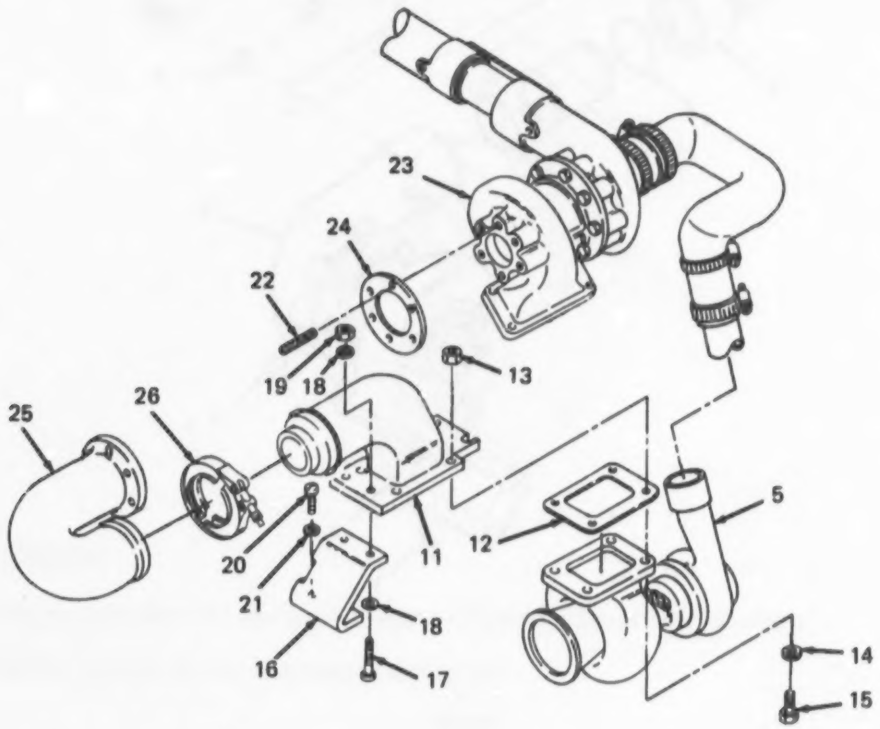
6 Position brace (16) on exhaust outlet connection (11) and secure using two screws (17), washers (18), an nuts (19).

7 Install two screws (20) and washers (21) securing two braces (16) to engine.

8 Install studs (22) (if required) in turbocharger (23).

9 Install turbocharger gasket (24).

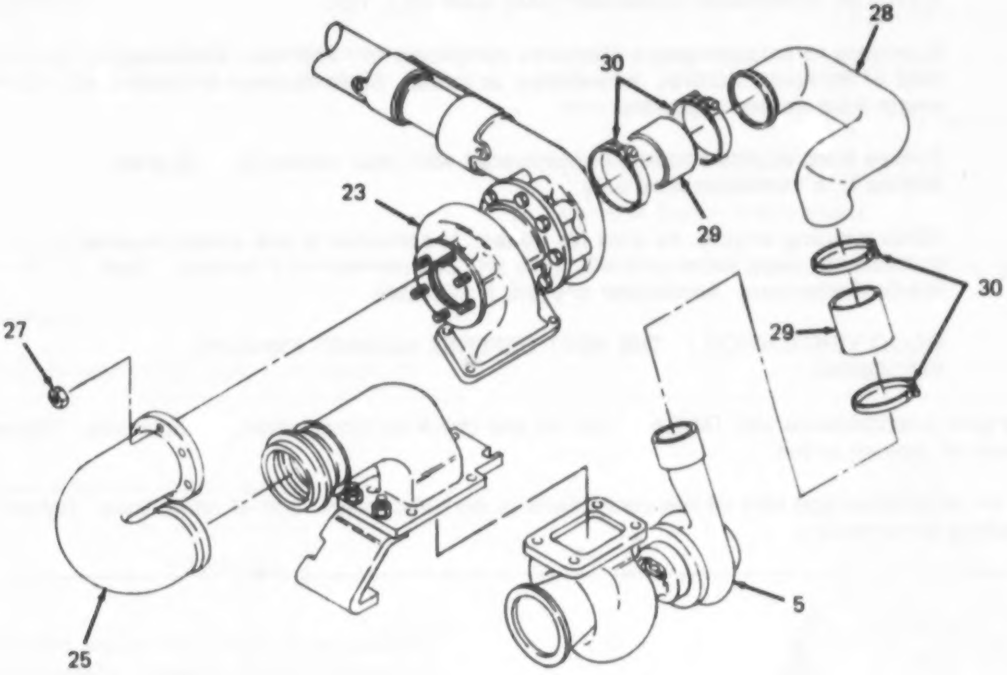
10 Position exhaust outlet connection (25) on exhaust outlet connection (11) and secure using V-band clamp (26).



2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

11 Secure exhaust outlet connection (25) to turbocharger (23) using six nuts (27).

12 Position air inlet pipe (28) and hoses (29) on turbochargers (5 and 23) and secure using clamps (30).



13 Install turbocharger plumbing and oil feed lines in accordance with paragraph 2-39.

14 Install exhaust elbow in accordance with paragraph 2-18.

15 Install air intake elbow in accordance with paragraph 2-38.

2-40. TURBOCHARGER REPLACEMENT REPAIR/REPLACE (CONT)

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10 and check for loose, rattling components. Tighten as necessary to prevent rattles.

2 Check for oil leaks around lube oil line connections to the turbocharger and oil return lines. Tighten connections as necessary.

2-41. DRIVE BELTS ADJUST/REPLACE

This task covers: a. Removal b. Inspection c. Installation/Adjustment

INITIAL SETUP

Test Equipment

Belt tension gauge, PN ST-1274 (Item 29, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Personnel Required

Two persons

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area required during operational check.

REMOVAL:

1 Remove alternator V-belts as follows:

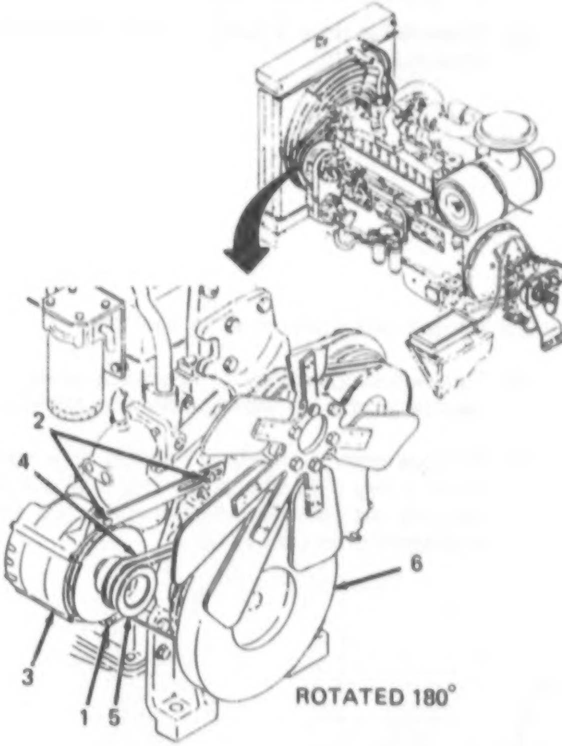
WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting.

(a) Loosen the alternator support bracket, capscrew, and nut assembly (1).

(b) Loosen two adjusting link capscrews (2).

(c) Carefully push alternator (3) toward engine until slack in alternator V-belts (4) is sufficient to lift belts off alternator pulley (5) and over engine flywheel (6).



2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

2 Remove water pump drive belt as follows:

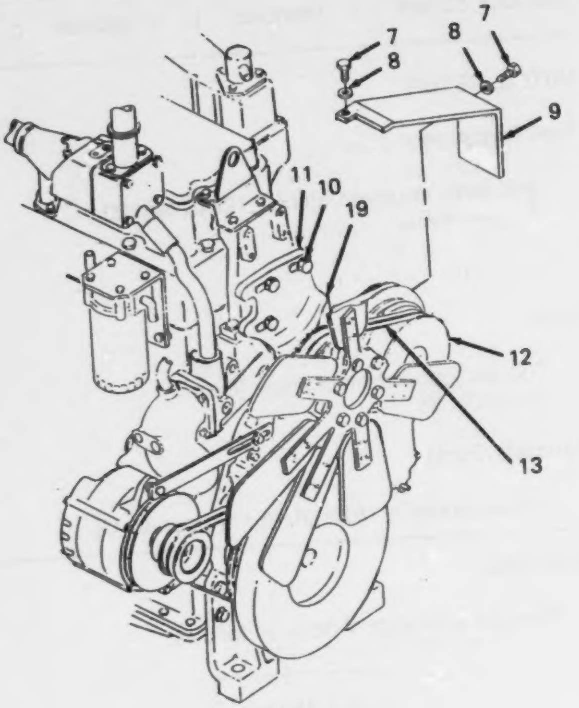
WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting.

(a) Remove two bolts (7) and washers (8) securing guard (9) to engine and remove guard.

(b) Loosen three screws (10) in fan hub bracket (11) and move bracket (11) toward accessory drive pulley (12) to take tension off fan drive V-belts (13).

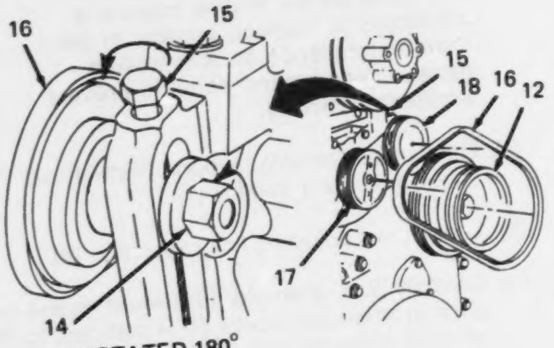
(c) Remove fan drive V-belts (13) from accessory drive pulley (12).



(d) Loosen idler pulley shaft locknut (14).

(e) Turn adjusting screw (15) counterclockwise to release tension on water pump drive belt (16).

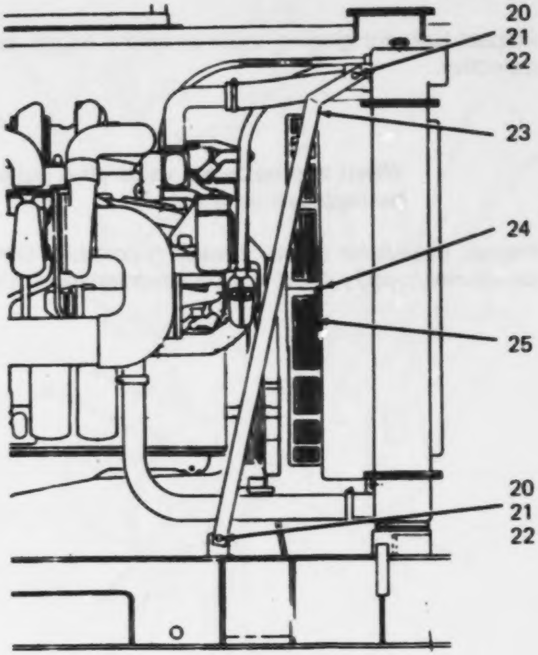
(f) Remove water pump drive belt (16) from water pump pulley (17), idler pulley (18), and pull drive belt (16) out between fan drive pulley (19) and accessory drive pulley (12).



ROTATED 180°

2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

3 Remove fan drive belts (13) as follows:



WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting.

(a) Remove two screws (20), nuts (21), and washers (22).

(b) Remove radiator bracket (23).

(c) Remove eight screws, washers, and lockwashers (24) that secure fan guard (25) to radiator.

NOTE

Fan guard must be rotated 90° counterclockwise to clear fan hub.

(d) Remove fan guard (25).

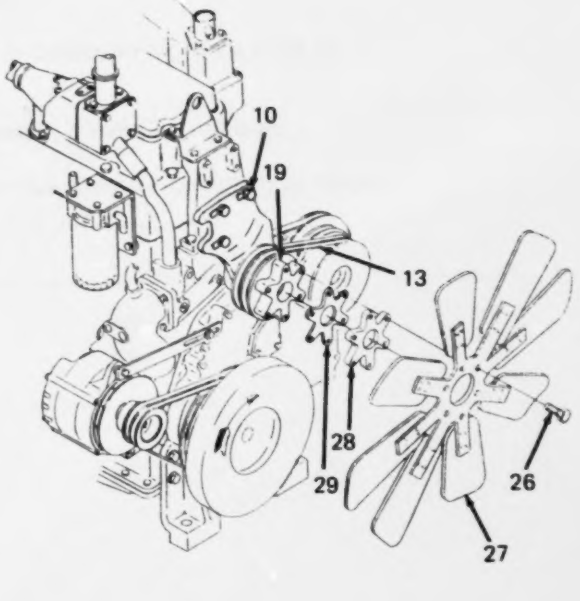
CAUTION

Hold fan securely while removing securing screws to prevent fan blades from damaging radiator.

(e) Remove six capscrews and lockwashers (26) and carefully remove fan (27) with fan pilot spacer (28) and fan spacer gasket (29).

(f) Loosen three capscrews (10) and move fan hub pulley (19) to relieve tension on fan drive belts (13).

(g) Remove fan drive belts (13).



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41. DRIVE BELTS ADJUST/REPLACE (CONT)

SPECTION:

Inspect belts for glazing; worn or frayed edges; and brittle, cracked, or broken rubber. Replace belts if defective.

NOTE

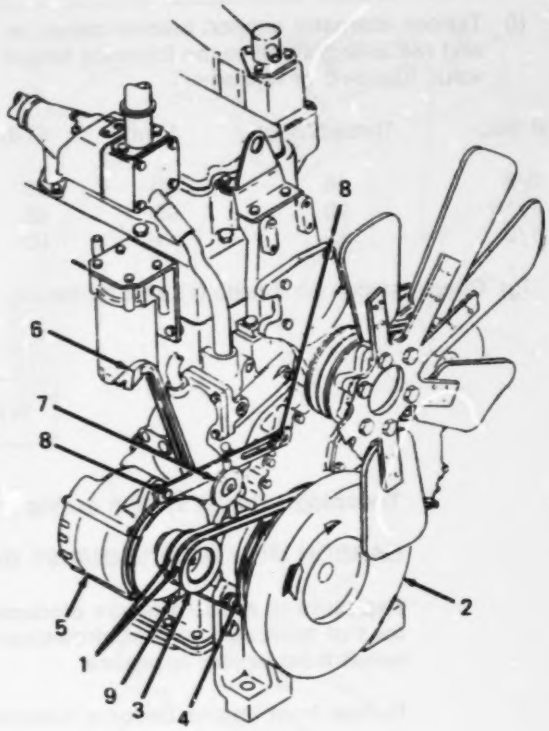
When two belts are used on a pulley, if either belt is damaged, both must be replaced as a set.

Inspect pulleys for cracks, broken grooves, or burring. If pulley is cracked, has broken grooves, or is burred excessively, notify direct support maintenance. Use crocus cloth or file to remove minor burrs.

2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

INSTALLATION/ADJUSTMENT:

1 Install and adjust alternator V-belts (1) as follows:



CAUTION

To prevent damage to belts, do not roll a belt over the pulley or pry it on with a tool.

NOTE

When a drive uses two or more belts, replace the belts as a complete set.

(a) Install alternator V-belts (1) over engine flywheel (2) and into place on alternator pulley (3) and crankshaft pulley (4).

(b) Carefully push alternator (5) away from engine to take up slack in V-belts (1).

(c) Use a pry bar (6) between engine and alternator (5) to gently apply tension to V-belts (1).

(d) Use tension gauge (7) to measure tension of V-belts (1). Tension for new belts should be 130 to 150 lb, for used belts 80 to 120 lb.

NOTE

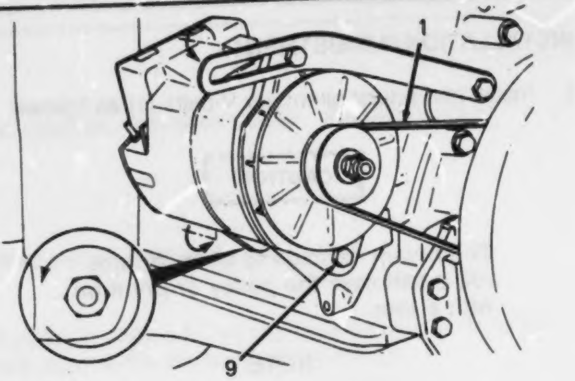
A belt is considered used if it has been in operation for more than 10 minutes.

If a belt will not maintain the correct tension, it must be replaced.

(e) Tighten two adjusting link capscrews (8) to torque value (Grade 5 or higher) as follows:

Bolt Size	Threads/Inch	N•m	Ft-lb
5/16	18	20	15
7/16	14	35	25
1/2	13	65	50

2-41. DRIVE BELTS ADJUST/REPLACE (CONT)



(f) Tighten alternator support bracket capscrew and nut assembly (9) to the following torque value (Grade 5 or higher):

Bolt Size	Threads/Inch	N•m	Ft-lb
3/8	16	40	30
7/16	20	90	65
1/2	13	110	80

(g) Check tension on V-belt (1) after tightening.

WARNING

Touching exhaust system during test can cause severe burns.

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Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engines in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

(h) Start engine in accordance with TM 5-4320-307-10.

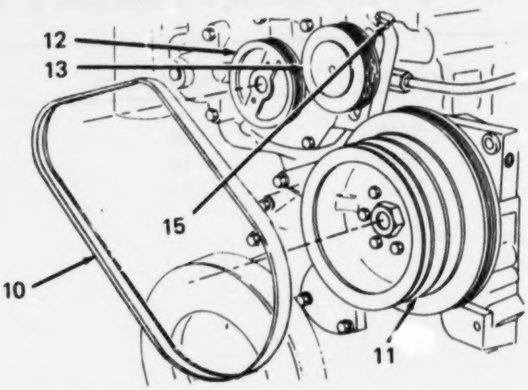
(i) Run engine for 10 minutes and recheck tension of belts. Readjust as needed.

2 Install and adjust water pump drive belt (10) as follows:

(a) Place water pump drive belt (10) over accessory drive pulley (11), fitting belt into groove at largest diameter of pulley.

(b) Install water pump drive belt (10) on water pump pulley (12) and idler pulley (13).

(c) Tighten idler pulley shaft locknut (14) to 5 to 6 ft-lbs (6.7 to 8 N•m) torque.

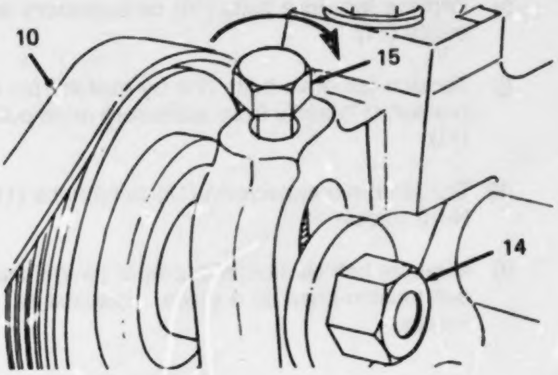


2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

(d) Turn the adjusting screw (15) to adjust water pump drive belt (10) tension.

NOTE

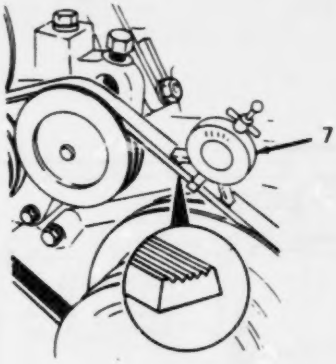
Belt tension can increase when the lock nut (14) is tightened. Do not adjust belt tension to full value with the adjusting screw (15).



(e) Use belt tension gage (7), part number ST-1293, to measure belt tension. Tension for new belts should be 150 to 160 ft-lbs (200 to 220 N m) torque. Tension for used belts should be 70 to 120 ft-lbs (95 to 165 N·m) torque.

NOTE

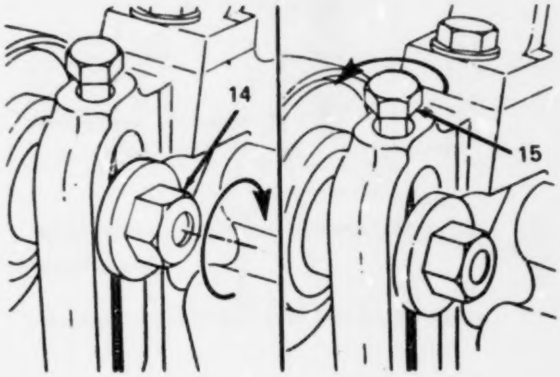
Do not use an ST-1274 belt tension gauge on V-ribbed belts because it will not give an accurate measurement.



(f) Tighten idler pulley shaft locknut (14) to 50 ft-lbs (70 N·m) torque.

(g) Loosen adjusting screw (15) 1/2 turn to prevent breakage.

(h) Measure belt tension again. Adjust if necessary.



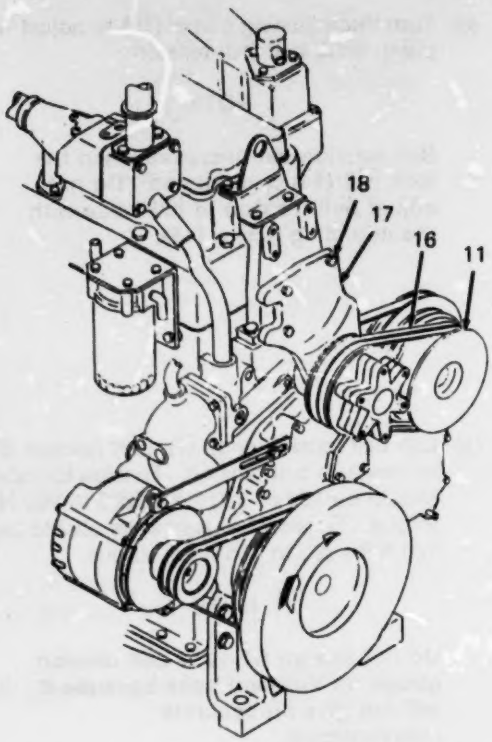
2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

(i) Replace fan drive belts (16) on accessory drive pulley (11).

(j) Tension fan drive belts (16) by pushing fan hub bracket (17) away from accessory drive pulley (11).

(k) Tighten three capscrews (18) to 80 ft-lbs (110 N·m) torque.

(l) Measure belt tension with proper gauge, using belt tension chart as a guide. Readjust as needed.



2-41. DRIVE BELTS ADJUST/REPLACE (CONT)

3 Install and adjust fan drive belts (16) as follows:

CAUTION

To prevent damage to belts do not roll a belt over the pulley or pry it with a tool.

(a) Install fan drive belts (16) on accessory drive pulley (11) and fan hub pulley (19).

(b) Move fan hub bracket (17) away from accessory drive pulley (11) to tension fan drive belts (16), and tighten three capscrews (18) to 80 ft-lbs (110 N·m) torque.

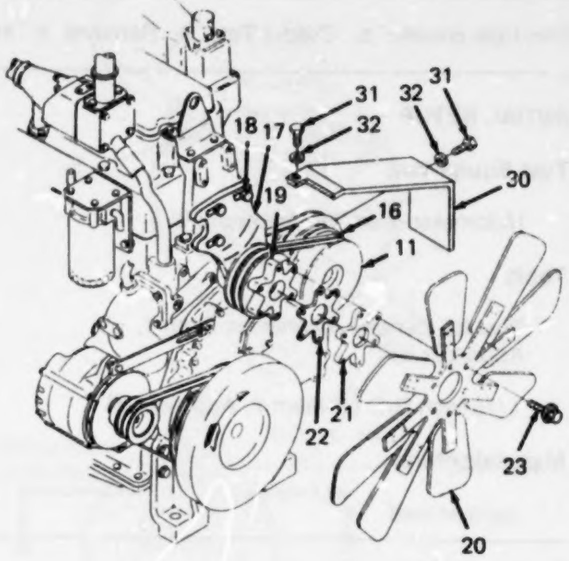
(c) Measure belt tension with proper gauge. Readjust as needed.

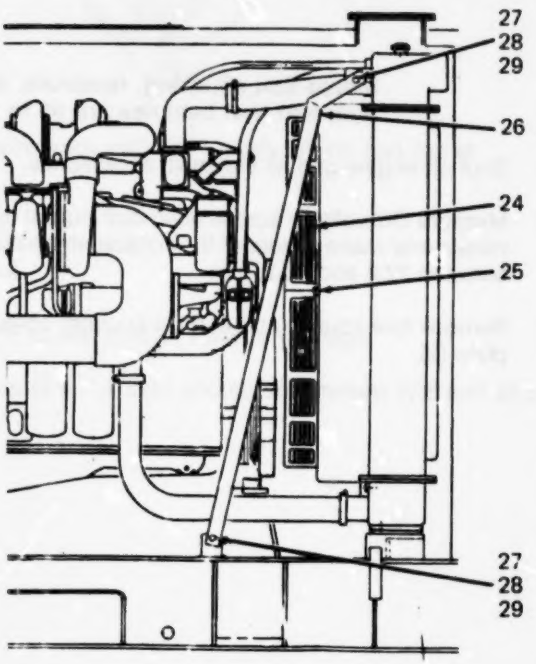
(d) Install fan (20) with fan pilot spacer (21) and fan spacer gasket (22) to fan hub pulley (19) using six capscrews and lockwashers (23).

(e) Install fan guard (24), with open area downward, using eight screws, lockwashers, and washers (25).

(f) Install radiator bracket (26) using two screws (27), washers (28), and nuts (29).

(g) Install belt guard (30) using screws (31) and washers (32).





2-42. ALTERNATOR TEST/REPLACE

This task covers: a. Output Test b. Removal c. Inspection d. Installation e. Operational Check

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

1/16-Inch Drill bit (Item 2, Appendix B)

Materials/Parts

Jumper lead

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-27	Battery check procedures
Paragraph 2-41	Alternator belts removed

OUTPUT TEST:

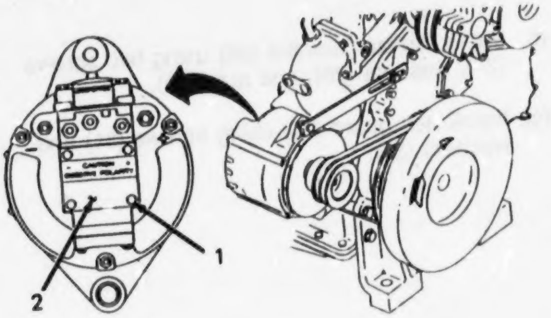
NOTE

Insure that all wiring, terminals, and batteries are in good working condition, and that batteries are 95 to 100% charged.

1 Shut off engine and all electrical accessories.

2 Measure DC voltage across alternator output terminals and make a note of it. Voltage should be between 27.8 and 28.2 Vdc.

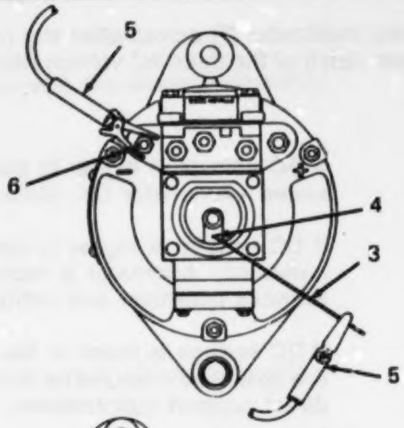
3 Remove four screws and O-rings (1) from cover plate (2).

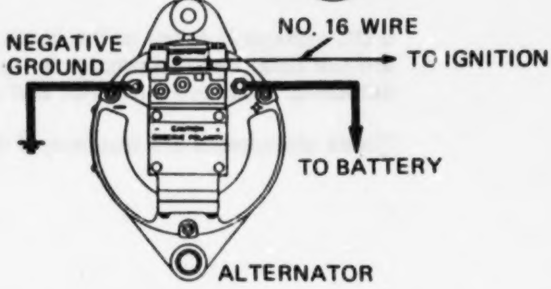


2-42. ALTERNATOR TEST/REPLACE (CONT)

4 Insert shank of 1/16-inch drill bit (3) in brush holder access hole (4).

5 Connect jumper (5) to negative output terminal (6) and to drill bit (3).




NEGATIVE GROUND
NO. 16 WIRE
TO IGNITION
TO BATTERY
ALTERNATOR

6 Connect multimeter to output terminals, start engine in accordance with TM 5-4320-307-10, and run at approximately 1200 to 1500 RPM.

CAUTION

Insure that all electrical accessories are OFF to avoid high voltage damage.

7 Check DC voltage across output terminals and make a note of it. Voltage should be between 27.8 and 28.2 Vdc.

42. ALTERNATOR TEST/REPLACE (CONT)

Connect multimeter (7) across alternator AC terminals (8) and (9), (8) and (10), and (9) and (10) and compare each of the three AC voltage readings.

NOTE

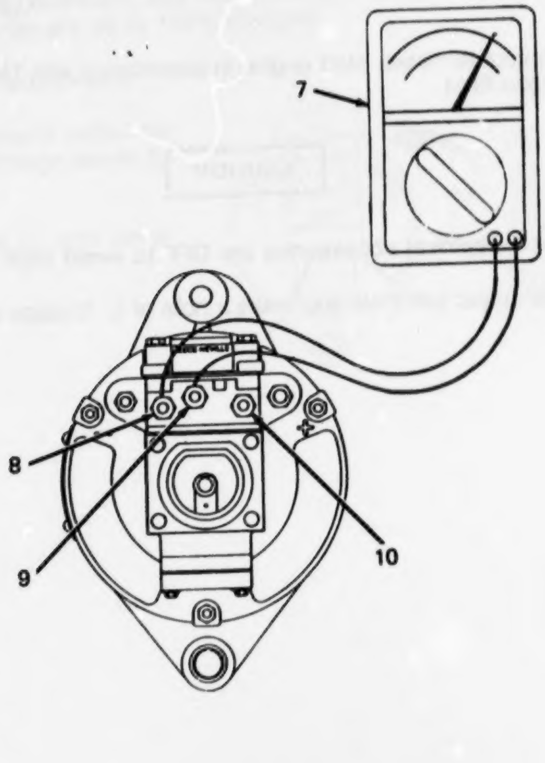
If DC voltage is higher in step 7 than in step 2 and AC voltages are balanced - Alternator OK, Stator OK. (See Adjustment task b.)

If DC voltage is higher in step 7 than in step 2 and AC voltages are not balanced - Alternator is malfunctioning. Stator or rectifier(s) is defective. Remove alternator and notify direct support maintenance.

If DC voltage is lower or the same in step 7 as in step 2 and AC voltages are balanced - Alternator is malfunctioning. Remove alternator and notify direct support maintenance.

If DC voltage is lower or the same in step 7 as in step 2 and AC voltages are not balanced - Alternator is malfunctioning. Stator or rectifier(s) is defective. Remove alternator and notify direct support maintenance.

These statements are true only if the batteries are 95 to 100% charged.



2-42. ALTERNATOR TEST/REPLACE (CONT)

NOTE

Stator is OK if all three AC voltages are approximately the same (balanced).

9 Remove jumper from output terminal.

10 Remove drill bit from brush holder.

11 Install O-ring and cover plate using four screws.

NOTE

If voltages observed are not within ranges stated, remove alternator and notify direct support.

2-42. ALTERNATOR TEST/REPLACE (CONT)

REMOVAL:

WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting. If it is necessary to run engine with rotating parts exposed, be sure the area around the moving parts is clear of personnel and tools.

Do not smoke or use open flame or spark-producing equipment in the vicinity of the battery.

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

CAUTION

Damage to the alternator could occur if the following precautions are not observed:

Do not reverse connecting polarity when connecting electrical leads and cables to the alternator.

Do not operate the alternator in an open circuit with the rotor winding energized.

Do not ground the alternator output circuit or field terminal.

Do not disconnect leads from alternator or other electrical components before disconnecting the negative (-) terminal from the battery.

Do not disconnect the battery while the alternator is operating.

Do not reverse battery cable connections.

1 Remove battery cables as follows:

CAUTION

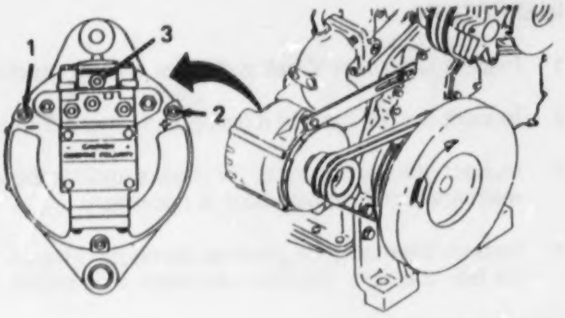
Disconnect battery cable from negative battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

(a) Loosen negative battery post terminals.

(b) Using battery terminal puller to remove loosened terminal lugs, remove negative battery terminal first.

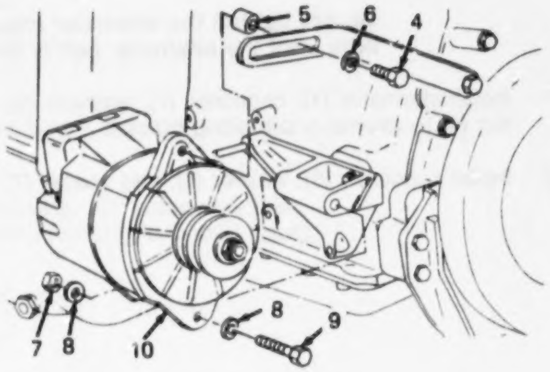
2-42. ALTERNATOR TEST/REPLACE (CONT)

2 Remove two output cables (1 and 2) and ignition lead wire (3).



3 Remove adjusting link capscrew (4), spacer (5), and washer (6).

4 Remove alternator support bracket nut (7), washers (8), capscrew (9), and alternator (10).



NOTE

For alternator disassembly, component testing, and repair notify direct support maintenance.

2-42. ALTERNATOR TEST/REPLACE (CONT)

INSPECTION:

1 Inspect alternator V-belt pulley for cracks, groove wear, or damage to keyway. Replace as required.

2 Inspect fan for bent or missing fins. Inspect mounting hole for wear. Replace as required.

3 Inspect voltage regulator for cracks and for loose or damaged terminals and leads. Notify direct support maintenance if replacement is necessary.

4 Inspect alternator for physical damage. Inspect shaft for stripped threads or worn keyway slot. Inspect shaft for free rotation. Replace alternator if damaged.

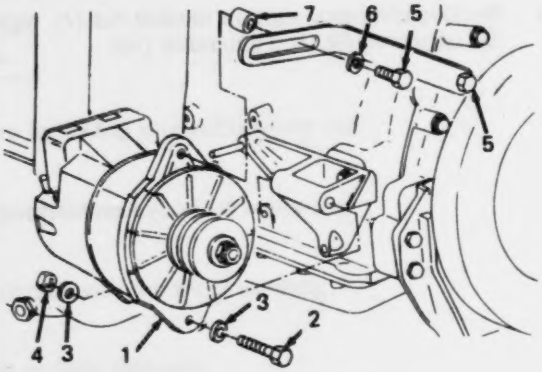
INSTALLATION:

NOTE

Do not tighten the alternator mounting and adjusting link capscrews and nuts until the alternator belt is installed and adjusted.

1 Install alternator (1), capscrew (2), washers (3), and nut (4) to alternator mounting bracket.

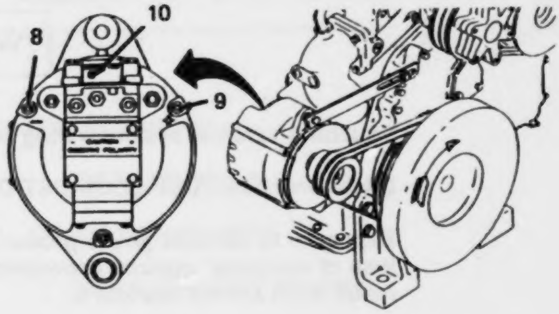
2 Install capscrew (5), washer (6), and spacer (7).



3 Install and adjust alternator belts. Refer to paragraph 2-41.

2-42. ALTERNATOR TEST/REPLACE (CONT)

4 Install two output cables (8 and 9) and ignition lead wire (10).



WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of the battery.

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

CAUTION

Damage to the alternator could occur if the following precautions are not observed:

Do not reverse connecting polarity when connecting electrical leads and cables to the alternator.

Do not operate the alternator in an open circuit with the rotor winding energized.

Do not ground the alternator output circuit or field terminal.

Do not disconnect leads from alternator or other electrical components before disconnecting the negative (-) terminal from the battery.

Do not disconnect the battery while the alternator is operating.

Do not reverse battery cable connections.

5 Install battery terminals and tighten terminal lugs.

2-42. ALTERNATOR TEST/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air, keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10. Check control panel battery voltmeter. The battery voltmeter indicator should be in the middle or green band on gage.

2 If indicator is not operating in green band on gage, check batteries and electrical system (paragraphs 2-27 and 2-28).

3 If battery and electrical systems are operating properly, replace alternator.

4 If condition still exists, recheck batteries and electrical system, then replace battery voltmeter in accordance with paragraph 2-28.

2-43. STARTER ASSEMBLY TEST/REPLACE

This task covers: a. Removal b. Test/Inspection c. Installation d. Operational Check

INITIAL SETUP

Test Equipment

RPM indicator

Ammeter (Item 2, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Manual References

TM 5-4320-307-10

Condition Description

Engine shut down and cool

REMOVAL:

WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of the battery.

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

NOTE

Ensure the batteries, wiring, and switches are in satisfactory condition and the engine is known to be functioning properly before removing starter motor.

1 Remove battery cables as follows:

CAUTION

Disconnect battery cable from negative battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the starter or other electrical components.

(a) Loosen negative battery post terminals.

(b) Using battery terminal puller to remove loosened terminal lugs, remove negative battery terminal first.

2-43. STARTER ASSEMBLY TEST/REPLACE (CONT)

2 Remove starter cables as follows:

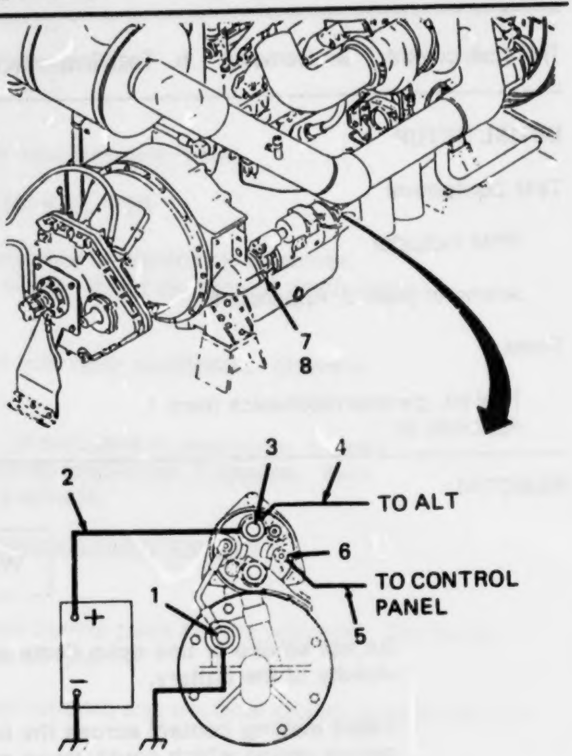
(a) Remove negative cable from negative starter post (1).

(b) Remove positive cable (2) from positive starter post (3).

(c) Remove starter switch terminal wire (4) from positive starter post (3).

(d) Remove magnetic switch terminal wire (5) from starter terminal (6).

3 Remove three bolts (7) and washers (8) and remove starter assembly from engine.



TEST/INSPECTION:

CAUTION

A cranking motor is designed for intermittent duty only, and should never be operated for more than 30 seconds at a time. After 30 seconds, the cranking must be stopped for at least 2 minutes to allow the motor to cool.

2-43. STARTER ASSEMBLY TEST/REPLACE (CONT)

1 Check armature for free rotation of pinion gear.

NOTE

Tight bearing, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely, replace starter and notify direct support maintenance. If the armature does turn freely, proceed to step 2 for a no-load test.

2 Perform a no-load test as follows:

NOTE

The no-load test may point to specific defects which can be verified with tests when disassembled. Also, the no-load test can identify open or shorted fields, which are difficult to check when disassembled. The no-load test also can be used to indicate normal operation on a repaired motor before installation.

2-43 STARTER ASSEMBLY TEST/REPLACE (CONT)

(a) Connect multimeter (1) from motor terminal (2) to ground terminal (3).

(b) Place rpm indicator (4) on armature shaft (5) to measure armature speed.

(c) Connect ammeter (6) in series between solenoid terminal "BAT" (7) and positive terminal of fully charged battery (8).

(d) Close switch (9) and compare the rpm current and voltage reading with the following readings:

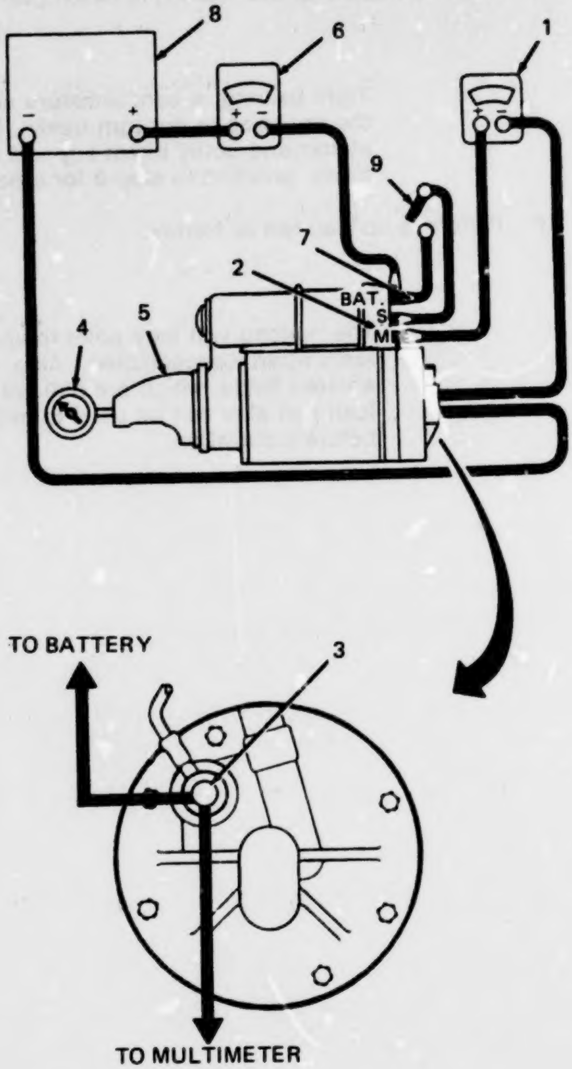
minimum voltage 20 Vdc

minimum amperage 60 amps

maximum amperage 75 amps

minimum rpm 6500

maximum rpm 7700



NOTE

It is not necessary to obtain the exact voltage specified as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the rpm will be proportionately higher, with the current remaining essentially unchanged.

Make disconnections only with the switch open.

2-43. STARTER ASSEMBLY TEST/REPLACE (CONT)

3 Interpret test results as follows:

(a) Rated current draw and no-load speed indicates normal condition of cranking motor.

(b) Low free speed and high current draw indicates:

(1) Too much friction; tight, dirty, worn bearings; bent armature shaft; or loose pole shoes allowing armature to drag.

(2) Shorted armature.

(3) Grounded armature or fields.

(c) Failure to operate with high current draw indicates:

(1) Direct ground in the terminal or fields.

(2) Seized bearings.

(d) Failure to operate with no current draw indicates:

(1) Open field circuit.

(2) Open armature coils.

(3) Broken brush springs, worn brushes, high insulation between commutator bars, or other causes which would prevent good contact between brushes and commutator.

(e) Low no-load speed and low current draw indicate high internal resistance due to poor connections, defective leads, and dirty commutator.

(f) High free speed and high current draw indicate shorted field.

NOTE

If any of the above conditions exist, notify direct support maintenance.

2-43. STARTER ASSEMBLY TEST/REPLACE (CONT)

INSTALLATION:

CAUTION

Be sure to use the same thickness of starter motor spacer (if used) as the one removed to install the starting motor to prevent engine or starter motor damage.

1 Install starting motor three capscrews (1) and washers (2). Tighten capscrews to 130 ft-lbs (176 N·m) torque.

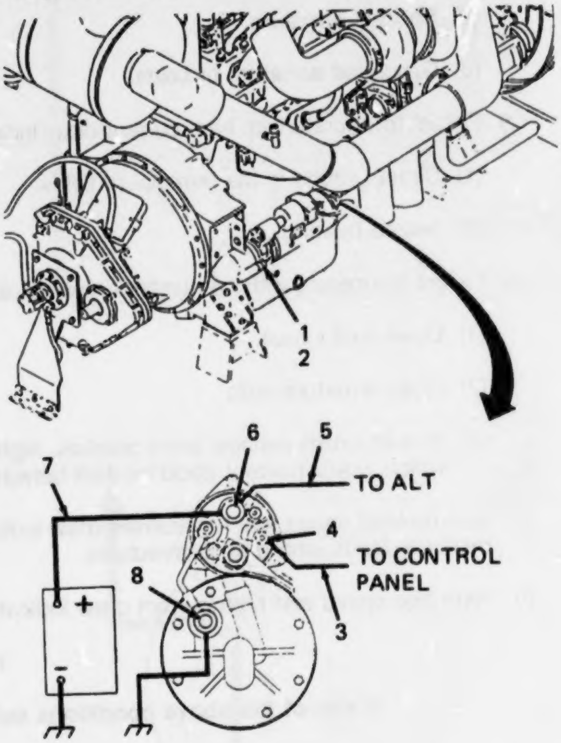
2 Install starter cables as follows:

(a) Install magnetic switch terminal wire (3) from terminal (4).

(b) Install starter switch terminal wire (5) on positive starter post (6).

(c) Install positive cable (7) on positive starter post (6).

(d) Install negative cable on negative starter post (8).



3 Install battery cables as follows:

WARNING

Do not smoke or use open flame or spark-producing equipment in the vicinity of the battery.

Avoid making contact across the battery terminals. This can result in severe arcing which could cause an explosion resulting in bodily injury.

CAUTION

Install battery cable from negative battery post last after connecting other leads. This precaution will prevent short circuits which could damage the starter or other electrical components.

Install and tighten the electrical connections to batteries.

2-43. STARTER ASSEMBLY TEST/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 If engine does not start, check and ensure the clutch operating lever is disengaged. Check the starter, electrical system, and batteries. If engine still will not start, refer to troubleshooting guide.

3 If all systems are working properly and engine still will not crank, notify direct support maintenance.

2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE

This task covers: a. Service b. Removal/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Filter wrench (Item 2, Appendix B)

Materials/Parts

Lubricating oil (Item 22, Appendix C)

Coolant filter

Cloth

Capped container

Manual References

TM 5-4320-307-10

General Safety Instructions

Coolant temperature must be below 120°F (50°C) before working on any part of cooling system.

Well ventilated area required during operational check.

SERVICE:

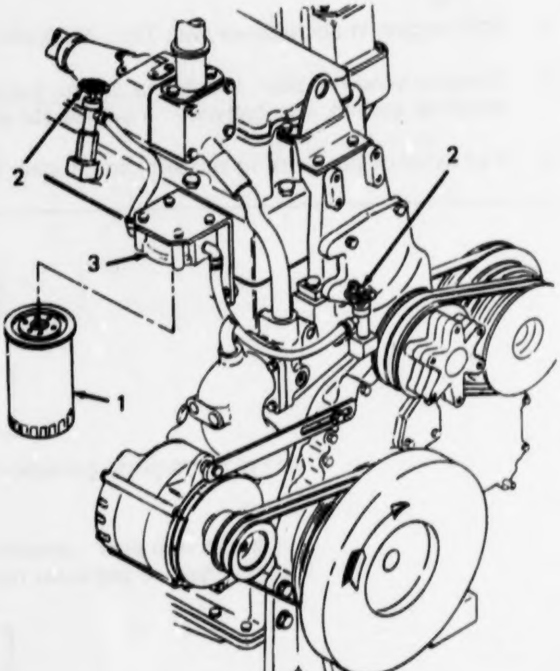
WARNING

Wait until the temperature is below 120°F (50°C) and close the shutoff valves before removing the coolant filter element. Failure to do so can cause personal injury from heated coolant spray.

1 Close two shutoff valves (2).

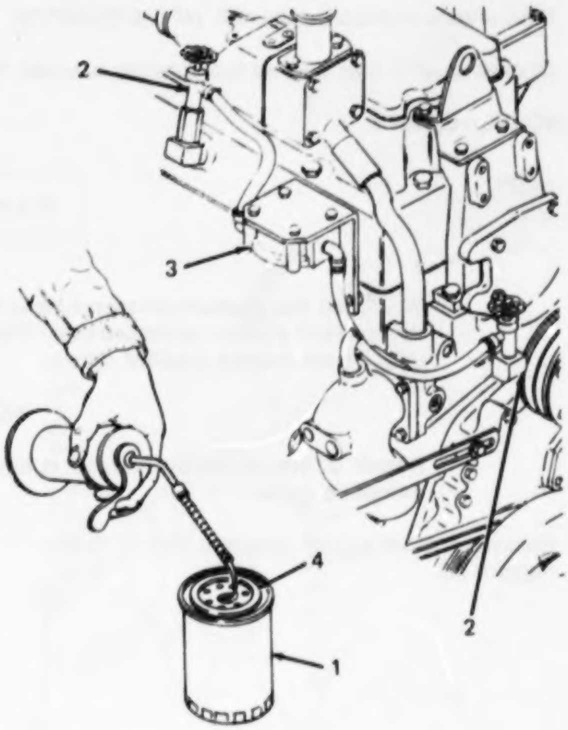
2 Remove and discard coolant filter (1).

3 Clean gasket surface on corrosion resistor head (3).



2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

4 Apply light film of lubricating oil to coolant filter gasket (4) sealing surface.



CAUTION

Mechanical overtightening may distort the threads or damage the filter head.

5 Install coolant filter (1).

6 Open two shutoff valves (2).

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

7 Start engine in accordance with TM 5-4320-307-10.

8 Operate engine until coolant temperature is above 180°F (80°C) and check for leaks.

REMOVAL/REPAIR:

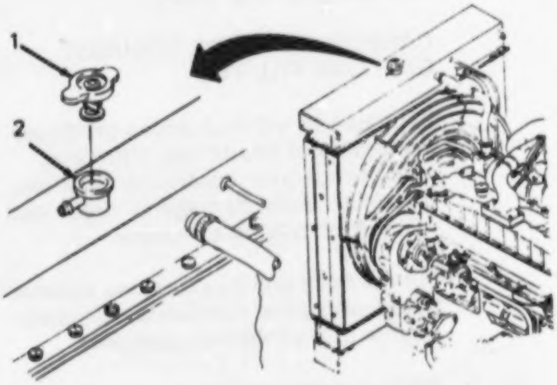
WARNING

Wait until the coolant temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can result in personal injury from heated coolant spray.

NOTE

Repair of the corrosion resistor is limited to replacement of damaged or defective parts.

1 Remove coolant system pressure cap (1) from radiator (2).



2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

2 Close shutoff valves (3 and 4).

3 Loosen hose clamp (5) and remove hose (6) from hose elbow (7).

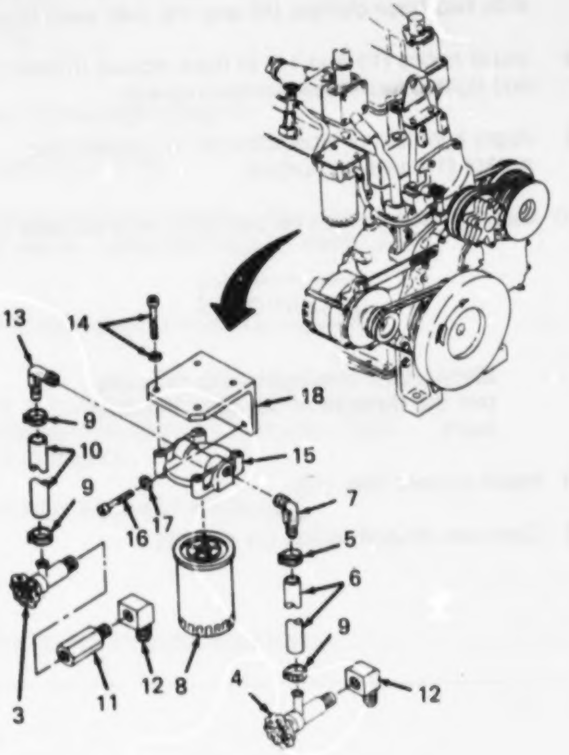
CAUTION

Use clean container with a cap to prevent entry of foreign material. Introduction of contaminants or foreign matter may cause premature failure of cooling system components.

4 Place hose (6) into clean, capped container and slowly open valve (4), allowing coolant to drain into container, until flow stops.

NOTE

Save the coolant.



5 Remove and discard coolant filter (8).

6 Loosen three hose clamps (9).

7 Remove hoses (6 and 10).

8 Unscrew and remove shutoff valves (3 and 4).

9 Remove adapter (11).

10 Remove elbows (12).

11 Remove hose elbows (7 and 13).

12 Remove four capscrew and captive washer assemblies (14) and remove corrosion resistor head (15).

13 Remove two capscrew and captive washer assemblies (16) with washers (17) and remove bracket (18) from engine.

INSTALLATION:

1 Install bracket (1) to engine with two capscrew and captive washer assemblies (2) and washers (3).

2 Install corrosion resistor head (4) to bracket (1) using four capscrew and captive washer assemblies (5).

3 Install hose elbows (6 and 7) to corrosion resistor head (4).

4 Install elbows (8).

5 Install adapter (9) to elbow (10).

6 Install shutoff valve (11) to adapter (9) and shutoff valve (12) to elbow (10).

2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

7 Install hoses (13 and 14) to valves (11 and 12) and slide two hose clamps (15 and 16) over each hose.

8 Install hoses (13 and 14) to hose elbows (6 and 7) and tighten four hose clamps in place.

9 Apply light film of lubricating oil to coolant filter gasket (17) sealing surface.

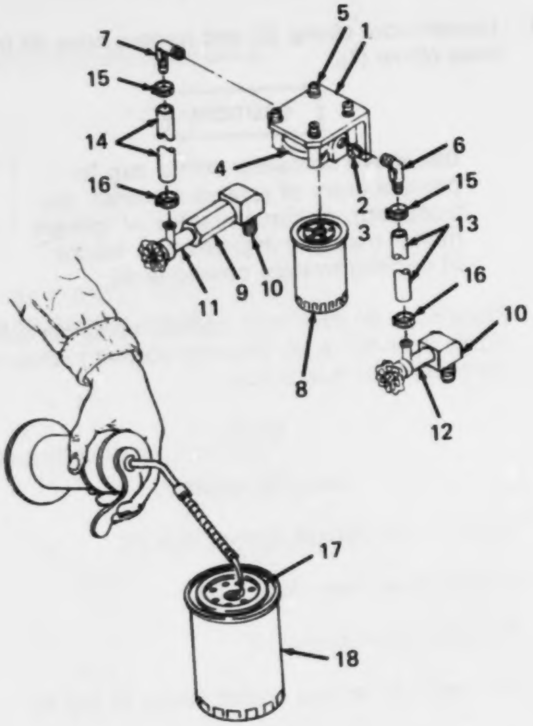
10 Clean gasket surface on corrosion resistor head (4).

CAUTION

Mechanical overtightening may distort the threads or damage the filter head.

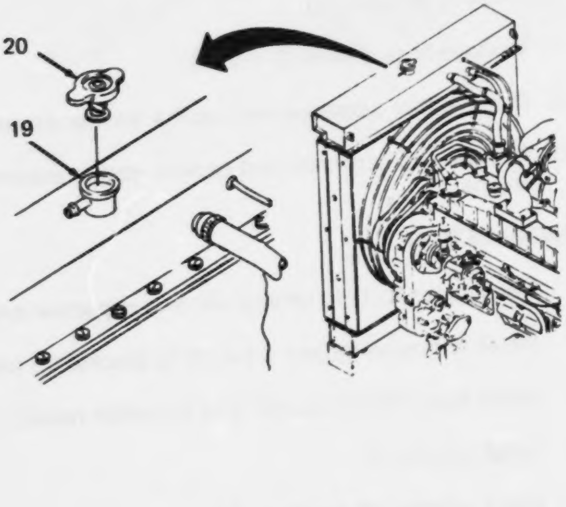
11 Install coolant filter (18).

12 Open two shutoff valves (11 and 12).



13 Replace coolant which had been drained from engine through radiator fill connection (19).

14 Replace coolant system pressure cap (20).



2-44. CORROSION RESISTOR ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engines in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

15 Start engine in accordance with TM 5-4320-307-10.

16 Operate engine until coolant temperature is above 180°F (80°C) and check for leaks.

2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation d. Pressure Test

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Seal mandrel (Item 30, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Grease (Item 14, Appendix C)

Gaskets

Seals

O-Rings

Antiseizing tape (Item 31, Appendix C)

Wire brush

Equipment Condition Reference	Condition Description
Paragraph 2-35	Radiator assembly drain
Paragraph 2-39	Turbocharger plumbing removed
Paragraph 2-40	Turbocharger removed
Paragraph 2-44	Corrosion resistor assembly removed
Paragraph 2-47	Water transfer tube disconnected

General Safety Instructions

Ensure coolant temperature is below 50°C (120°F) before servicing water manifold or thermostat housing assembly.

Well ventilated area

REMOVAL:

WARNING

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

1 Drain cooling system in accordance with paragraph 2-35.

2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

2 Remove water transfer tube (1) as follows:

(a) Remove one capscrew and washer (2).

(b) Remove water transfer tube (1) from oil cooler support and water manifold.

(c) Remove and discard two O-ring seals (3).

3 Remove water bypass tube (4) as follows:

(a) Remove one capscrew (5) and clamp (6).

(b) Remove two hose clamps (7).

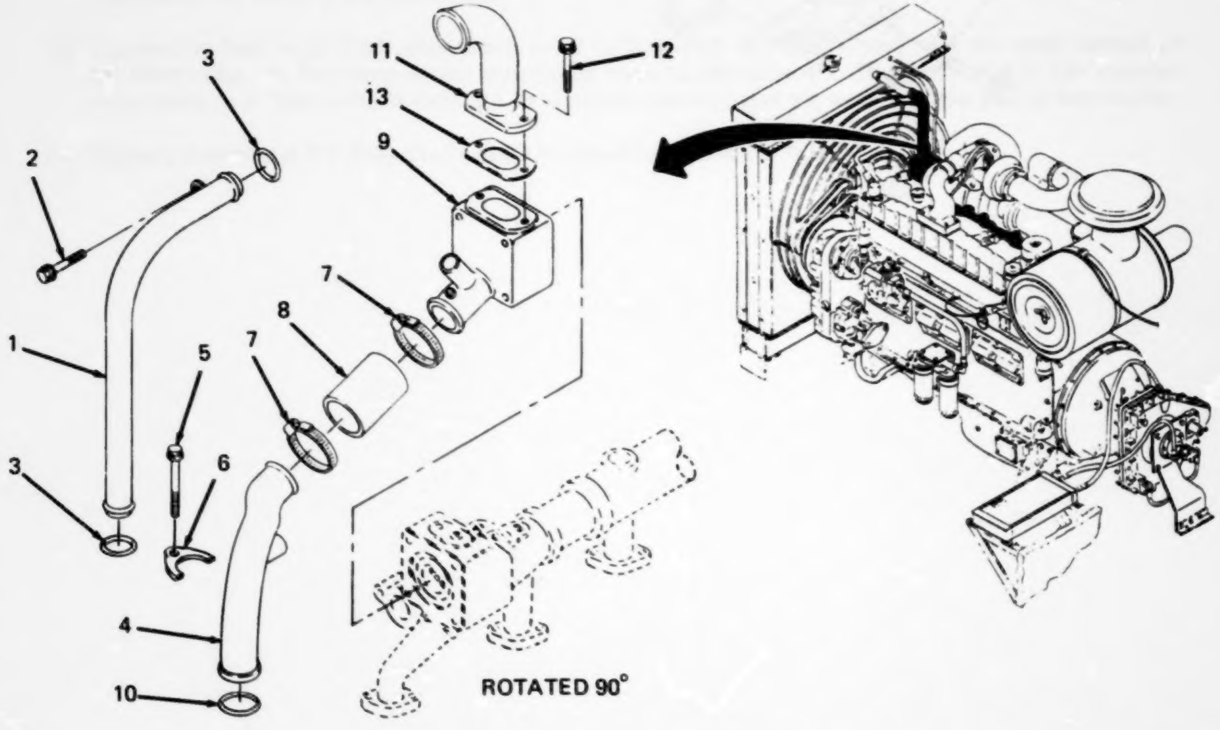
(c) Remove plain hose (8) from thermostat housing (9) and bypass tube (4).

(d) Remove water bypass tube (4) and discard O-ring seal (10).

4 Remove water connection (11) as follows:

(a) Remove two capscrews (12).

(b) Remove water connection (11) and gasket (13) from thermostat housing (9).

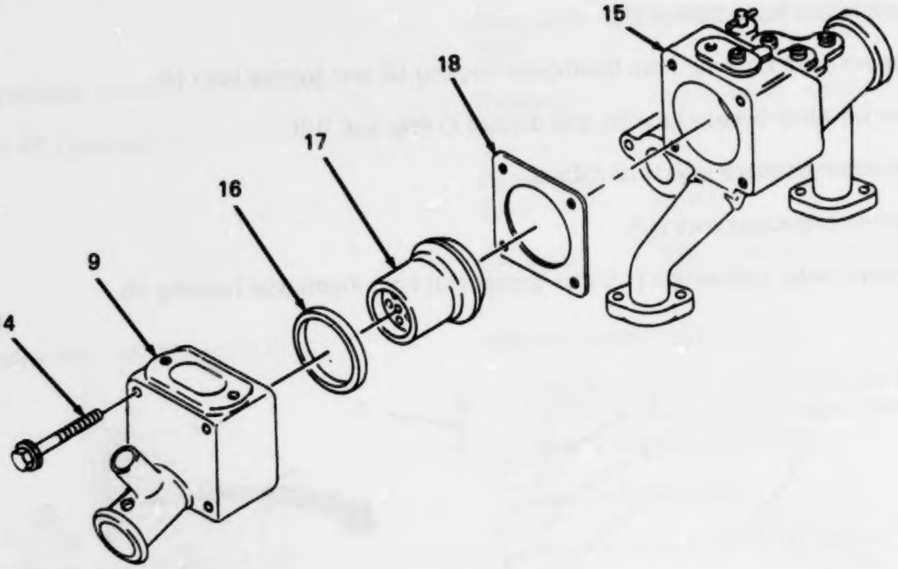


2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

5 Remove thermostat and housing as follows:

(a) Remove four capscrews and lockwashers (14) and remove thermostat housing (9) from water manifold (15).

(b) Remove thermostat seal (16), thermostat (17), and thermostat gasket (18).



2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (Safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

1 Use wire brush and/or dry cleaning solvent to clean the thermostat housing. Inspect for breaks, cracks, and excessive corrosion. Repair is limited to the replacement of faulty items.

2 Inspect drain cock for proper opening and closing. Replace if defective.

3 Check operation of thermostat as follows:

(a) Check body of thermostat to find at what temperature thermostat is in open position.

(b) Put thermostat and a thermometer into container of water. Use a device to hold the thermostat and thermometer so that they will not touch container.

(c) Heat water. Thermostat must begin to open when temperature of water is at the same temperature marked on the body of the thermostat.

(d) Continue to heat water until temperature is 15° to 20°F (8.3° to 11.1°C) more than the value marked on the thermostat. At this temperature, thermostat must be fully opened. The thermostat is fully opened when there is at least a 0.375 inch (9.5 mm) space between seal sleeve and brass part of thermostat.

(e) Replace thermostat if it does not operate in correct temperature range.

2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

REPLACEMENT:

1 Install thermostat and housing as follows:

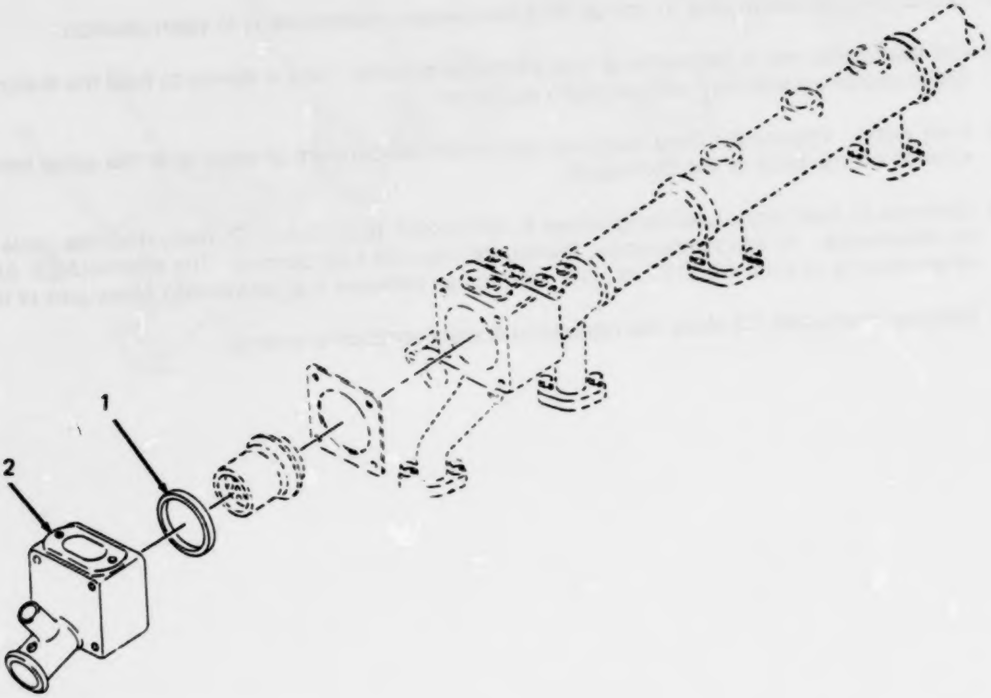
(a) Install thermostat seal (1) as follows:

(1) Place thermostat seal (1) into housing (2) with part number on metal side of seal against manifold.

NOTE

Make sure the seal is correctly installed. If the seal is not correctly installed, engine coolant can leak past the seal when the thermostat is in the closed position. This can cause the engine temperature to be colder than normal.

(2) Insert seal (1).



2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

(b) Slide the sleeve of thermostat (3) through seal in housing (2).

(c) Position thermostat gasket (4) against water manifold (5).

(d) Insert four capscrews (6) and fasten housing (2) to water manifold (5).

2 Install water connection (7) as follows:

(a) Place gasket (8) in place on housing (2).

(b) Install two capscrews (9) and fasten water connection (7) to housing (2).

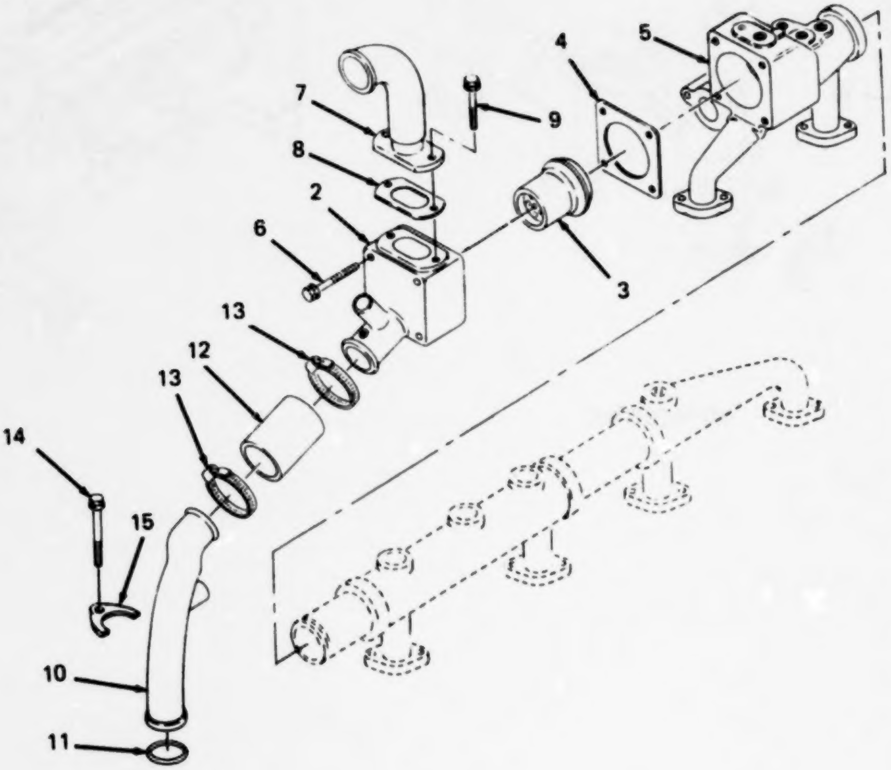
3 Install water bypass tube (10) as follows:

(a) Coat new O-ring seal (11) with GAA grease and install.

(b) Insert bypass tube into housing.

(c) Install plain hose (12) to thermostat housing (2) and bypass tube (10) and fasten with two hose clamps (13). Tighten hose clamps to 40 in-lbs (5 N·m) torque.

(d) Install capscrew (14) and clamp (15).



2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

4 Install water transfer tube (16) as follows:

(a) Coat two new O-ring seals (17) with GAA grease and install.

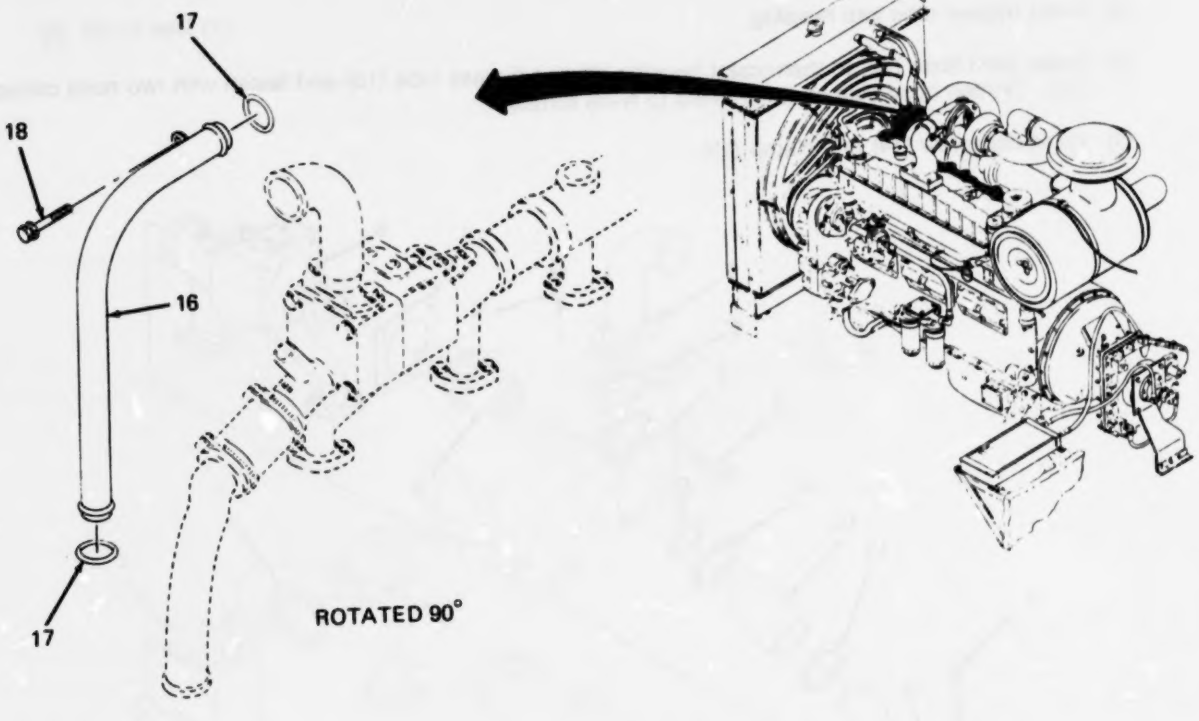
(b) Insert capscrew (18) and fasten transfer tube (16) to oil cooler support and water manifold.

5 Fill cooling system in accordance with paragraph 2-35.

6 Install turbochargers in accordance with paragraph 2-40.

7 Install turbocharger plumbing in accordance with paragraph 2-39.

8 Install corrosion resistor assembly in accordance with paragraph 2-44.



2-45. THERMOSTAT HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

PRESSURE TEST:

NOTE

Pressure test the system in accordance with paragraph 2-35.

2-46. EXHAUST MANIFOLD ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Inspection/Repair c. Installation d. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Antiseize compound (Item 6, Appendix C)

Adhesive (Item 3, Appendix C)

Gaskets

Seals

Emory cloth (240 grit) (Item 2, Appendix C)

Personnel Required

Two

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-40	Turbochargers, air inlet pipe, and exhaust outlet connection removed
Paragraph 2-44	Engine coolant filter assembly removed

General Safety Instructions

Unit cool before starting task

Well ventilated area required during operational check.

2-46. EXHAUST MANIFOLD ASSEMBLY REPAIR/REPLACE (CONT)

REMOVAL:

1 Remove exhaust manifold assembly (1) as follows:

(a) Remove one capscrew (2) at each end of exhaust manifold assembly (1) and install two guide studs (3) in their place.

WARNING

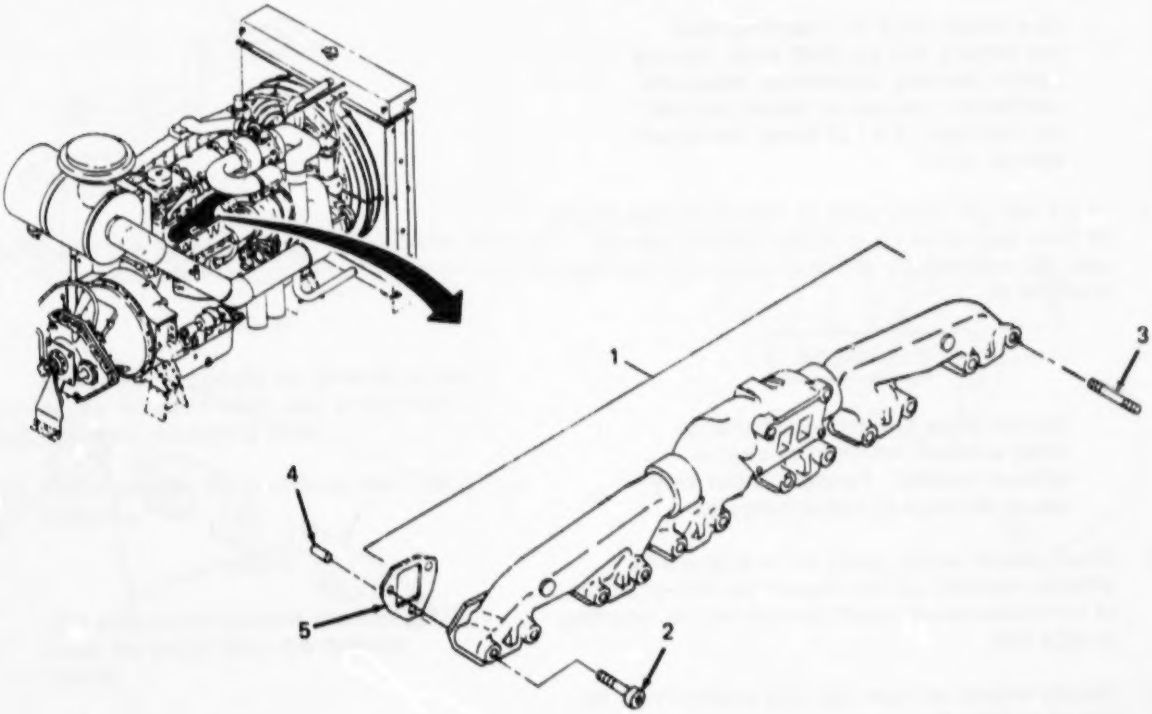
Because this assembly weighs more than 50 lbs (23 kg), two people are required to lift the exhaust manifold assembly to avoid personal injury.

(b) Remove remaining nine capscrews (2).

CAUTION

Two dowels (4) are used to align exhaust manifold to cylinder head. Manifold should be pulled clear of dowels before lifting vertically to avoid damaging dowels.

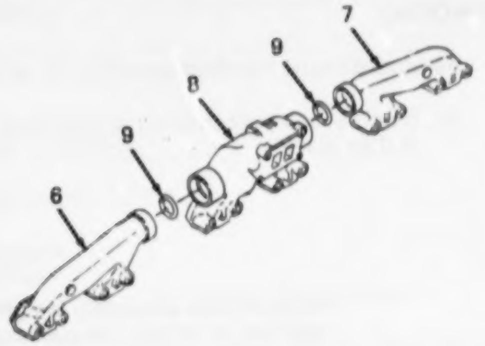
(c) Remove exhaust manifold assembly (1) with manifold gaskets (5) and discard gaskets.



2-46. EXHAUST MANIFOLD ASSEMBLY REPAIR/REPLACE (CONT)

(d) Separate rear manifold (6) and front manifold (7) from center manifold (8).

(e) Remove and discard seals (9).



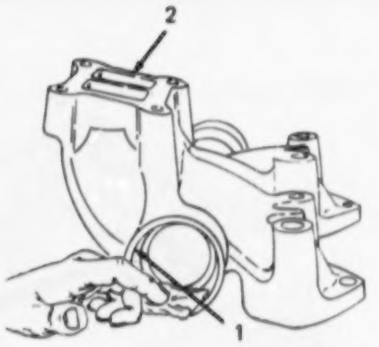
INSPECTION/REPAIR:

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

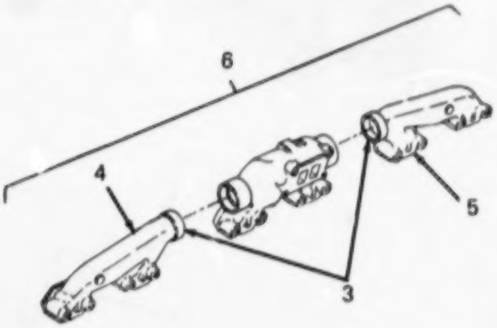
1 Use a 240 grit emery cloth to remove carbon deposits from seal bores (1) in center manifold (2) and seal ring surfaces (3) of rear manifold (4) and front manifold (5).



CAUTION

Do not allow any foreign matter to enter exhaust manifold or engine exhaust outlets. Foreign matter may cause damage to turbochargers.

2 Clean gasket sealing surfaces on engine and exhaust manifold (6) and inspect for pitting, cracks, or conditions which would prevent secure mounting or tight seal.



3 Visually inspect exhaust manifold assembly (6) for cracks or damage.

4 Inspect mounting capscrews for thread damage.

5 Repair is limited to the replacement of defective components.

INSTALLATION:

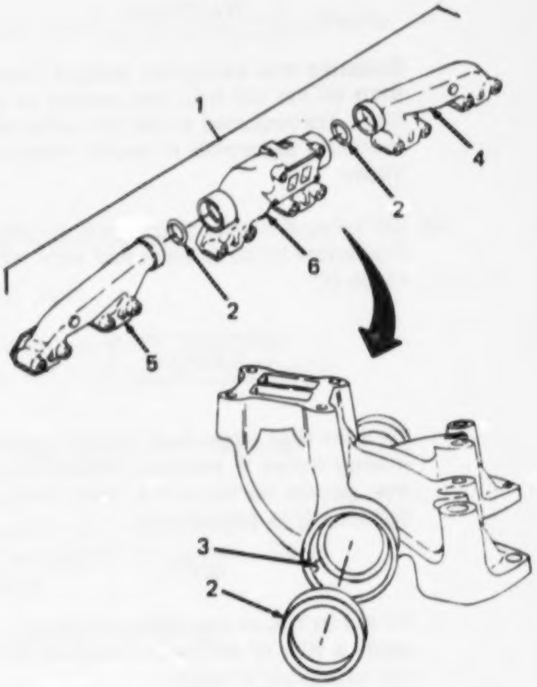
1 Install exhaust manifold (1) as follows:

NOTE

The exhaust manifold sections must be assembled on a flat surface.

(a) Install seals (2) in seal ring grooves (3).

(b) Install front manifold (4) and rear manifold (5) to center manifold (6).



(c) Install two guide studs (7) into cylinder head (8) if they are not installed from removal procedure.

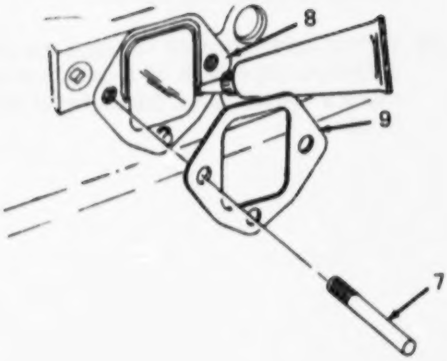
NOTE

Guide studs should be located in last screw holes at each end of exhaust manifold mounting area.

(d) Install gaskets (9) to cylinder head (8) using adhesive.

NOTE

The side of the gasket marked "OUT" must be away from the cylinder heads.

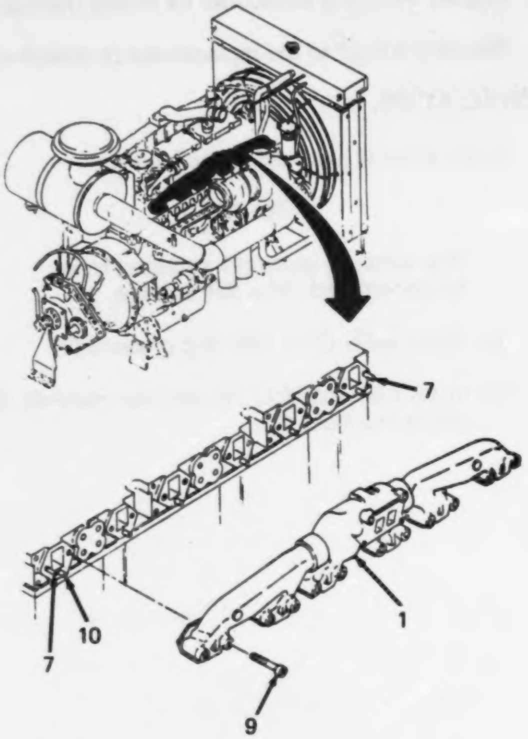


2-46. EXHAUST MANIFOLD ASSEMBLY REPAIR/REPLACE (CONT)

WARNING

Because this assembly weighs more than 50 lbs (23 kg), two people or a hoist are required to lift the exhaust manifold assembly to avoid personal injury.

(e) Lift exhaust manifold assembly (1) into place so that screw holes at each end align with guide studs (7).



CAUTION

Be sure that alignment dowels enter mating holes in exhaust manifold and that gasket surfaces are flush before tightening in capscrews.

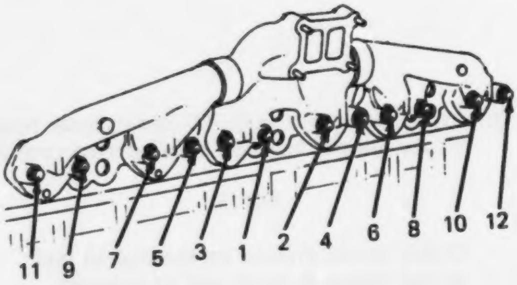
NOTE

To aid in future capscrew removal, apply a film of antiseize compound to the capscrew threads.

(f) Push exhaust manifold (1) in over guide studs (7) to mate with engine and hand tighten 10 capscrews (9) in place. Be sure that dowels (10) have entered dowel holes in exhaust manifold (1).

(g) Remove guide studs (7) and replace with capscrews (9) and hand tighten.

(h) Tighten capscrews (9) in sequence shown. First tighten all capscrews 35 ft-lbs (45 N•m), then make a second pass, tightening to 60 ft-lbs (80 N•m).



2-46. EXHAUST MANIFOLD ASSEMBLY REPAIR/REPLACE (CONT)

2 Install turbochargers, air inlet pipe, engine coolant filter assembly, and exhaust outlet connection in accordance with paragraph 2-40.

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Operate engine to check for exhaust and supply air leaks.

2-47. AFTERCOOLER REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Gaskets

O-ring seals

Wire brush

Personnel Required

Two

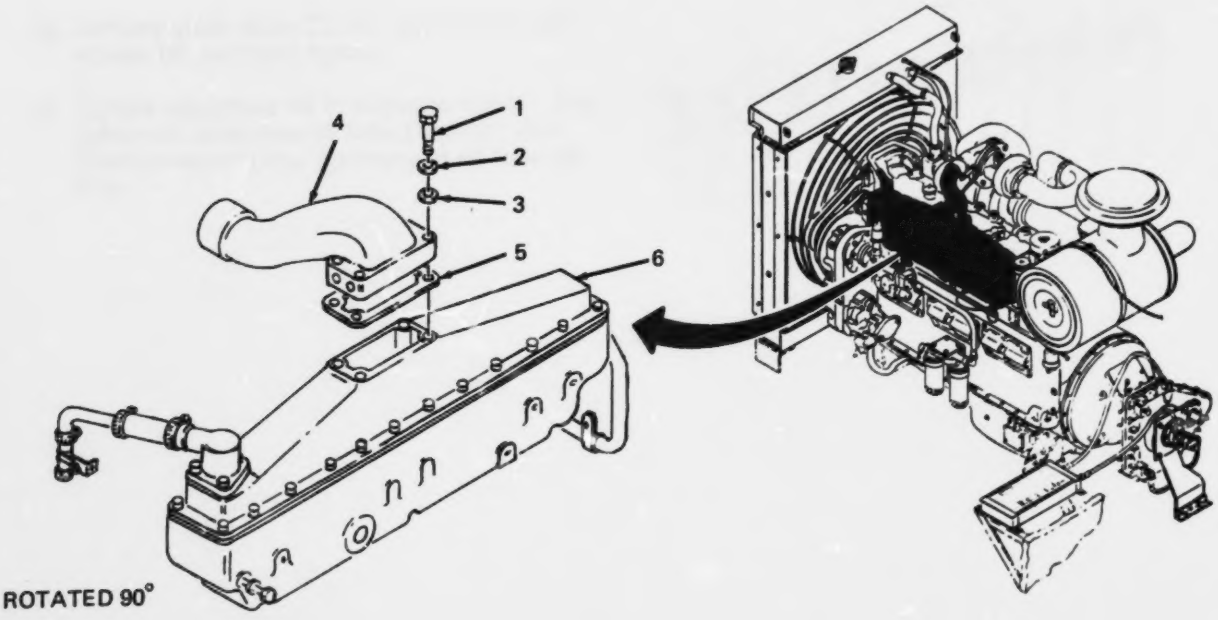
Equipment Condition Reference	Condition Description
Paragraph 2-35	Cooling system drained
	Engine shut down and cool
Paragraph 2-40	Turbocharger straps removed

General Safety Instructions

Well ventilated area

REMOVAL:

1 Remove four capscrews (1), washers (2), and washers (3) securing air crossover connection (4) and connection gasket (5) to aftercooler cover (6).



2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

2 Remove two capscrews (7), lockwashers (8), and clips (9) securing water transfer tube (10) to engine.

3 Loosen four hose clamps (11) and remove water transfer tube (10) and hoses (12).

4 Remove two capscrews (13) securing water inlet connection (14) and water transfer connection gasket (15) to air intake manifold (16) and remove water inlet connection and gasket (15).

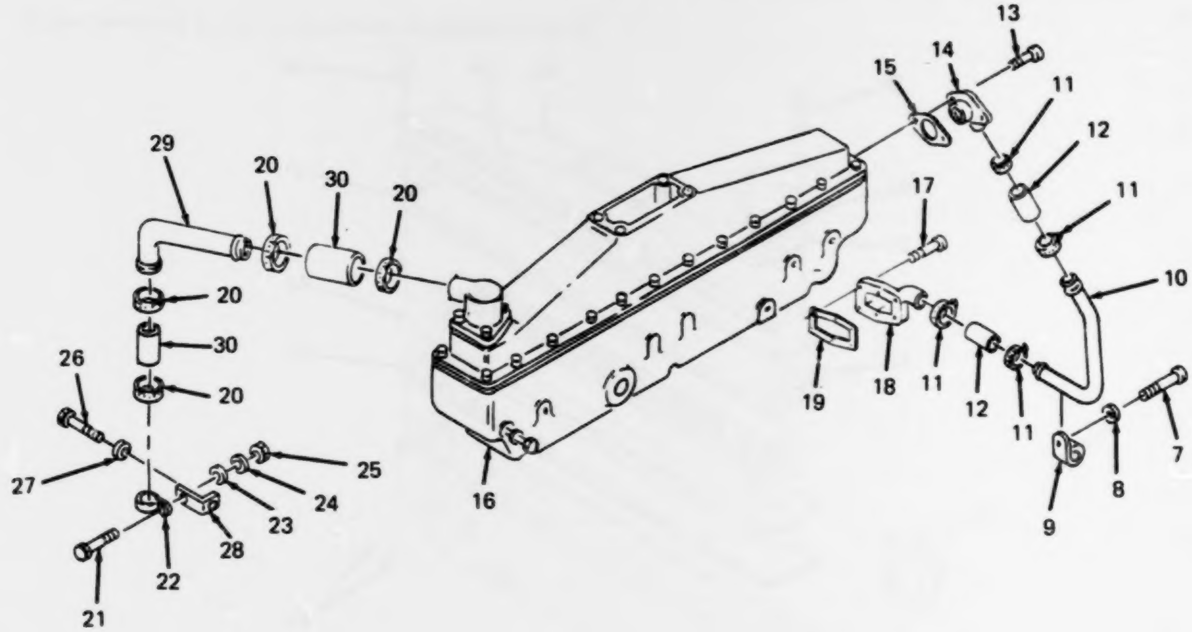
5 Remove six screws (17) securing water outlet connection (18) and water connection gasket (19) to air intake manifold (16).

6 Loosen four hose clamps (20).

7 Remove capscrew (21), clip (22), washer (23), lockwasher (24), and nut (25).

8 Remove captive capscrew (26) and washer (27) securing tube brace (28) to engine.

9 Remove water transfer tube (29) and hoses (30).



2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

WARNING

Aftercooler weighs more than 50 lbs (23 kg). Use two people or suitable lifting device to prevent injury to personnel.

10 Remove six capscrews and washers (31).

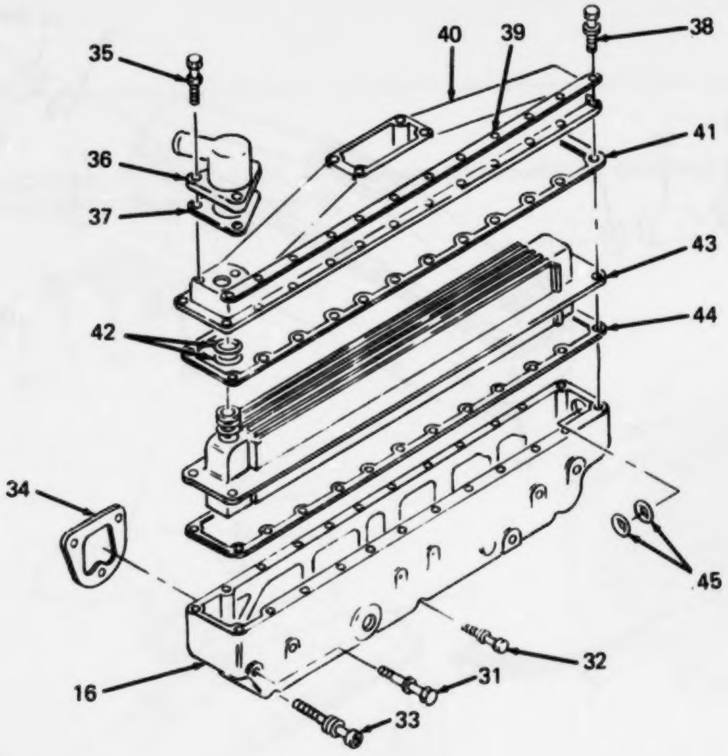
11 Remove two capscrews and washers (32), allen screw, washer, and lockwasher (33) and remove aftercooler and three intake manifold gaskets (34).

12 Remove three screws and lockwashers (35) and remove water outlet connection (36) and water transfer gasket (37).

13 Remove 24 captive capscrews (38) and remove cover supports (39), aftercooler cover (40), and aftercooler housing gasket (41).

14 Remove two O-ring seals (42).

15 Remove aftercooler core (43), gasket (44), and two O-ring seals (45).



2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flashpoint of P-D-680 is 100° to 138°F (38° to 59°C).

1 Use a wire brush and/or dry cleaning solvent to clean aftercooler assembly.

2 Inspect aftercooler assembly for breaks, cracks, and excessive corrosion. Inspect core for leaks.

NOTE

If core is leaking or requires further maintenance, notify direct support maintenance.

3 Repair is limited to the replacement of defective items.

2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

INSTALLATION:

1 Position two O-ring seals (1), gasket (2), and aftercooler core (3) in air intake manifold (4).

2 Install two O-ring seals (5).

3 Position aftercooler housing gasket (6), cover supports (7), aftercooler cover (8) and secure using 24 capscrews (9).

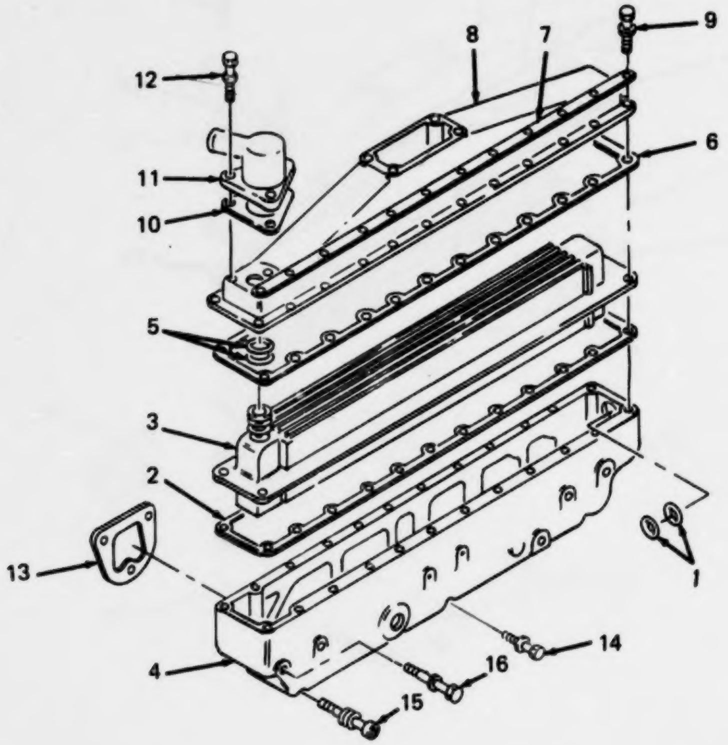
4 Position water transfer gasket (10) and water outlet connection (11) and secure using three screws and washers (12).

WARNING

Aftercooler weighs more than 50 lbs (23 kg). Use two people or suitable lifting device to prevent injury to personnel.

5 Position aftercooler and three intake manifold gaskets (13) and secure using two capscrews and washers (14), allen screw, washer, and lockwasher (15).

6 Install six capscrews and washers (16).



2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

7 Position water transfer tube (17) and hoses (18) on engine.

8 Position tube brace (19) on engine and secure using washer (20) and capscrew (21).

9 Install clip (22), capscrew (23), washer (24), lockwasher (25), and nut (26).

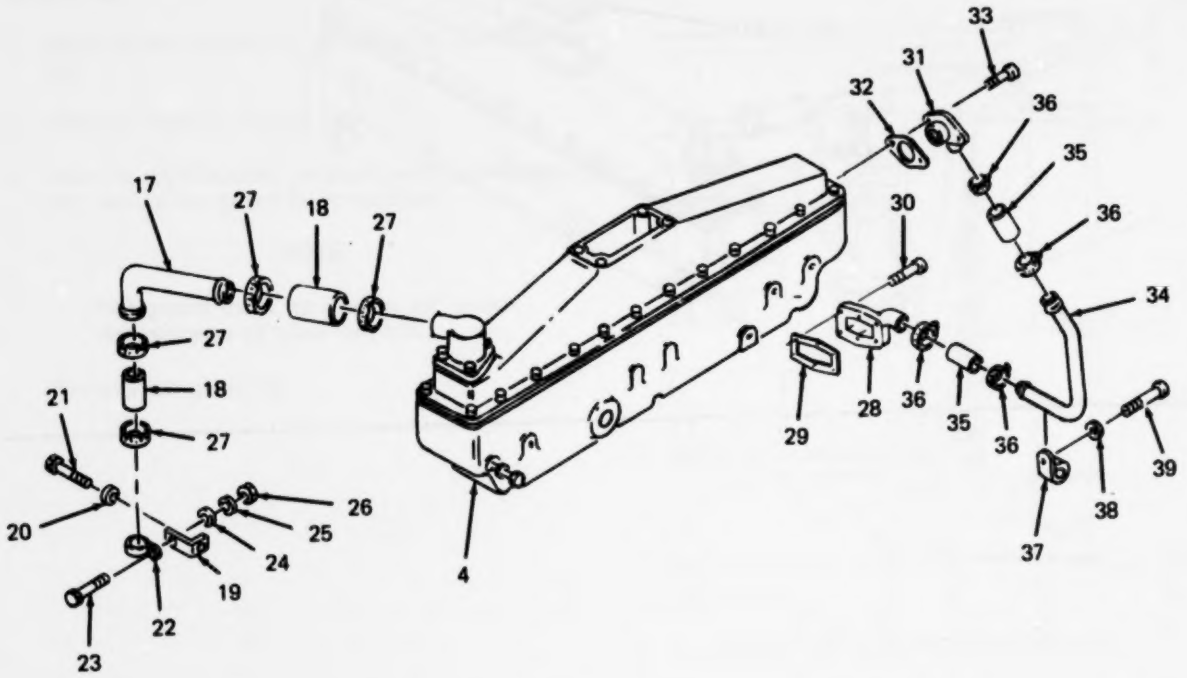
10 Tighten hose clamps (27).

11 Position water outlet connection (28) and water connection gasket (29) on air intake manifold (4) and secure using six screws (30).

12 Position water inlet connection (31) and water transfer connection gasket (32) on air intake manifold (4) and secure using two capscrews (33).

13 Position water transfer tube (34) and hoses (35) on engine and secure using hose clamps (36).

14 Position two clips (37) on water transfer tube (34) and secure using lockwashers (38) and capscrews (39).

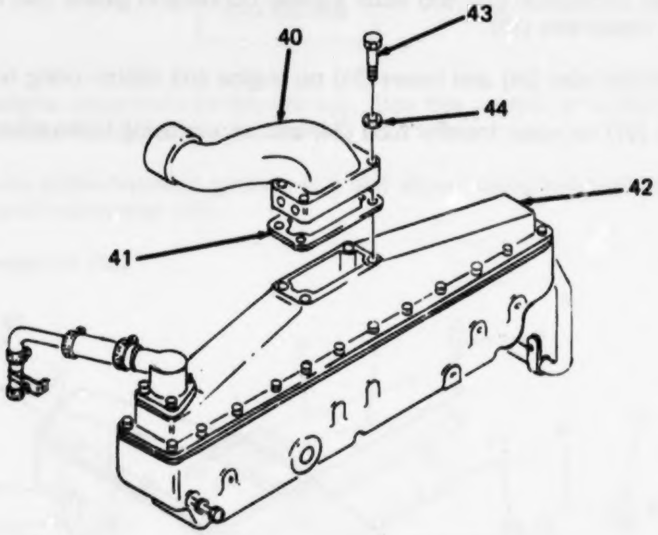


2-47. AFTERCOOLER REPAIR/REPLACE (CONT)

15 Position air crossover connection (40) and connection gasket (41) on aftercooler cover (42) and secure using four capscrews (43), and washers (44). Tighten capscrews (43) to 25 ft-lb (35 N•m) torque.

16 Install turbocharger straps in accordance with paragraph 2-40.

17 Fill cooling system in accordance with paragraph 2-35.



2-48. FAN HUB AND BRACKET REPLACE

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

Test Equipment

Dial indicator (Item 5, Appendix B)

Belt tension gage (Item 29, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appencix B)

Materials/Parts

Fan spacer gasket

Personnel Required

Two

REMOVAL:

1 Remove two screws (1), two nuts (2), and washers (3).

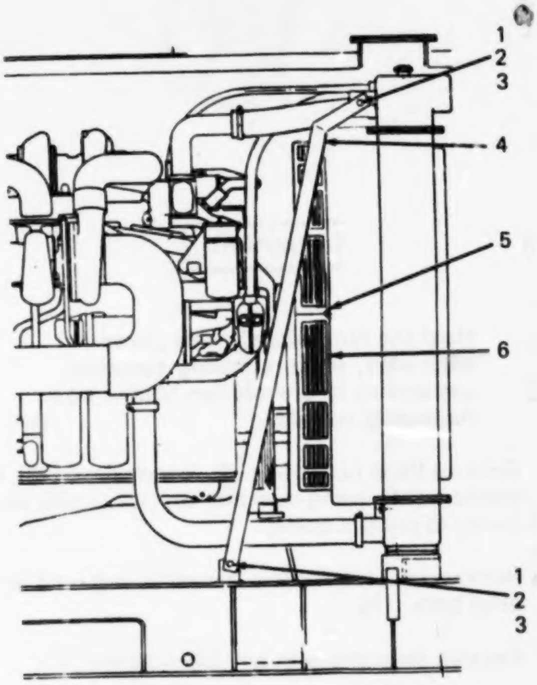
2 Remove radiator bracket (4).

3 Remove eight screws, washers, and lockwashers (5) that secure fan guard (6) to radiator.

NOTE

Fan guard must be rotated 90° counterclockwise to clear fan hub.

4 Remove fan guard (6).



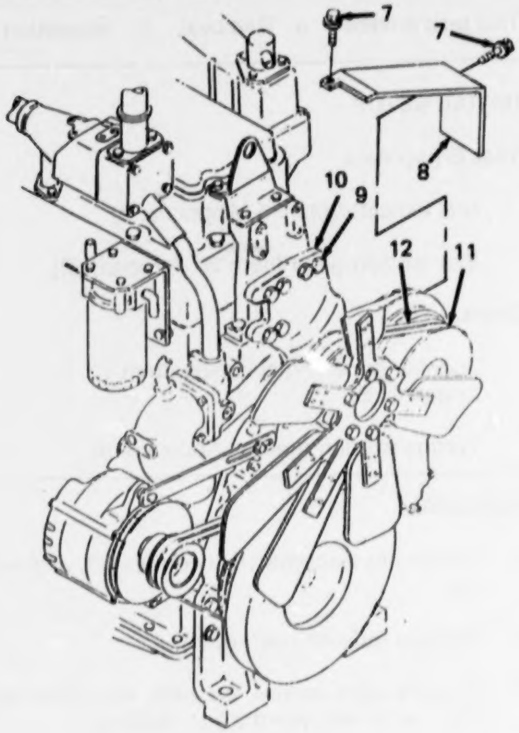
2-48. FAN HUB AND BRACKET REPLACE (CONT)

5 Remove two bolts and washers (7) securing guard (8) to engine and remove guard.

6 Loosen three capscrews (9).

7 Shift fan hub bracket (10) toward accessory drive pulley (11) to relieve tension on fan drive belts (12).

8 Remove fan drive belts (12) from accessory drive pulley (11).



CAUTION

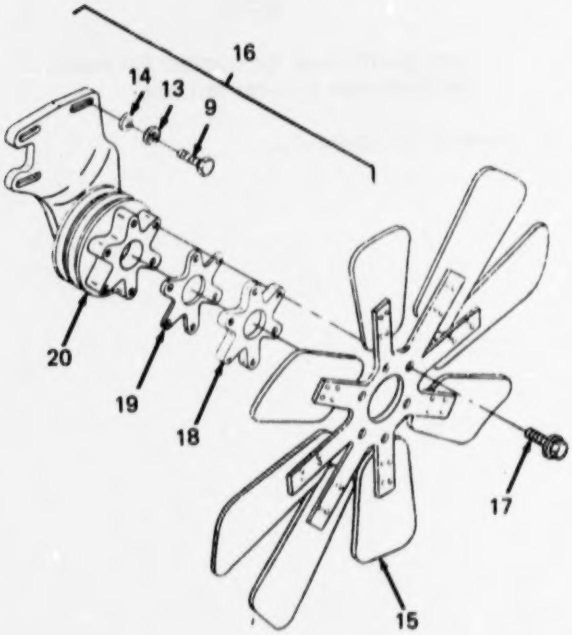
Hold the fan securely, one person at each side, while removing securing capscrews to prevent fan blades from damaging radiator.

9 Remove three capscrews (9), lockwashers (13), and washers (14), being sure that fan (15) is held securely to prevent falling.

10 Remove fan (15), fan hub assembly (16), and fan drive belts (12).

11 Remove six capscrews and lockwashers (17).

12 Remove fan (15), fan pilot spacer (18) and fan spacer gasket (19) from fan hub pulley (20).



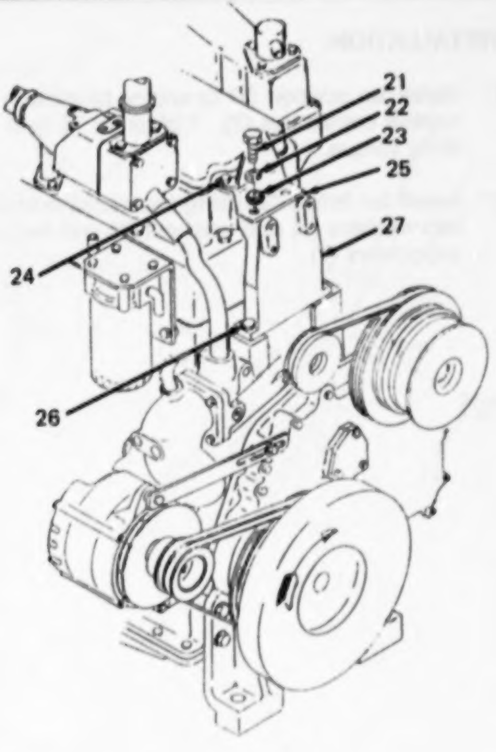
2-48. FAN HUB AND BRACKET REPLACE (CONT)

13 Remove two capscrews (21), lockwashers (22), and washers (23).

14 Unscrew two captive capscrews (24).

15 Remove fan brace (25).

16 Unscrew two captive capscrews (26) and remove fan support (27).



INSPECTION:

1 Inspect fan hub assembly for the following:

   (a) Freedom of rotation.

   (b) Cracks.

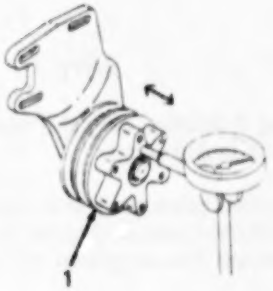
   (c) Grease seal leakage.

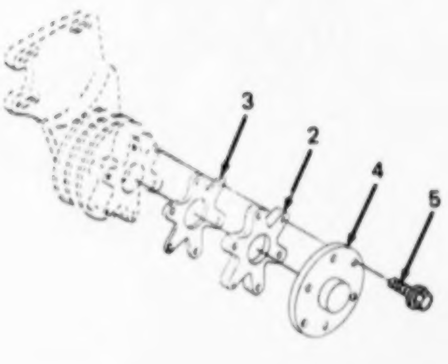
2 Replace fan hub assembly if fan pulley (1) does not rotate freely or if there is evidence of cracks or grease seal breakage.

3 Measure fan pulley (1) end clearance. End clearance must be 0.003 inch to 0.010 inch (0.08 mm to 0.25 mm).

4 Replace fan hub assembly if end clearance is not within above specifications.

5 Attach fan pilot spacer (2), fan spacer gasket (3), and protective shipping cover (4) using capscrew and lockwasher (5), and forward defective fan hub assembly to direct support maintenance.



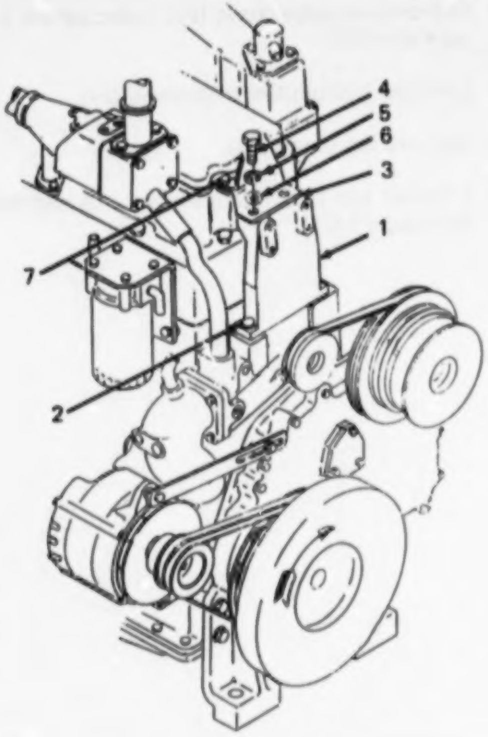


2-48. FAN HUB AND BRACKET REPLACE (CONT)

INSTALLATION:

1 **Install fan support (1) to engine block with two captive capscrews (2). Tighten to 75 in-lb (100 N•m) torque.**

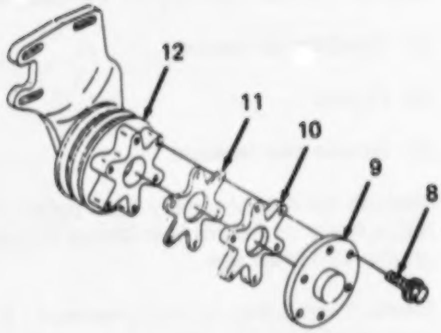
2 **Install fan brace (3) using two capscrews (4) with lockwashers (5) and washers (6) and two captive capscrews (7).**



NOTE

Step 3 applies only if a new assembly is being used.

3 **Remove two capscrews and lockwashers (8) and take protective shipping cover (9), fan pilot spacer (10), and fan spacer gasket (11) off fan pulley (12).**



2-48. FAN HUB AND BRACKET REPLACE (CONT)

4 Install fan (13), fan pilot spacer (10), and fan spacer gasket (11) to fan pulley (12) with six capscrews and washers (14).

5 Place two fan drive bolts (15) on fan pulley (12).

CAUTION

The fan should be held securely, one person at each side, to prevent fan blades damaging the radiator.

NOTE

When a drive uses two or more belts, replace the belts as a complete set.

6 Secure fan hub bracket (16) to fan support (1) by hand, tightening three capscrews (17) with lockwashers (18) and washers (19).

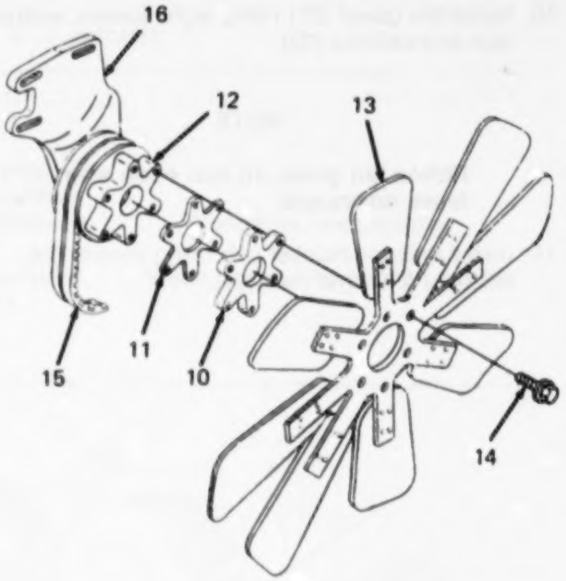
CAUTION

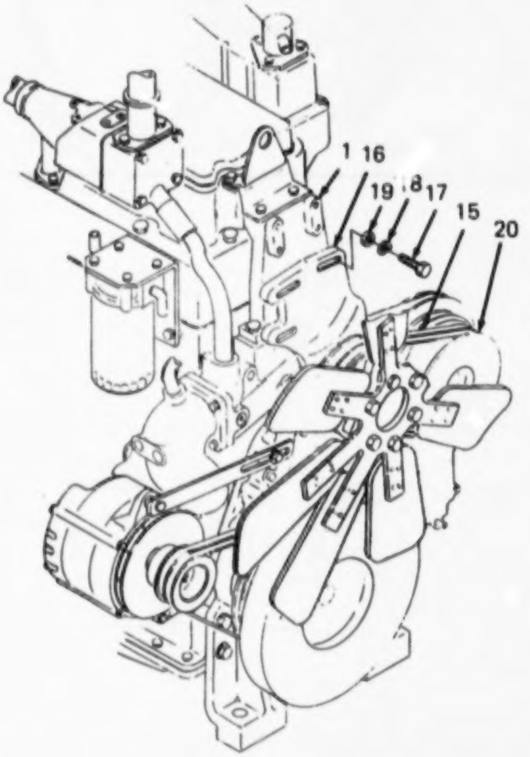
To prevent damage to belts, do not roll a belt over the pulley or pry it on with a tool.

7 Move fan hub bracket (16) towards accessory drive pulley (20) and install fan belts (15) on accessory drive pulley (20).

8 Push fan hub bracket (16) away from accessory drive pulley (20) to tension belts (15), and tighten three capscrews (17) to 80 ft-lbs (110 N m) torque.

9 Adjust belt tension in accordance with paragraph 2-41.





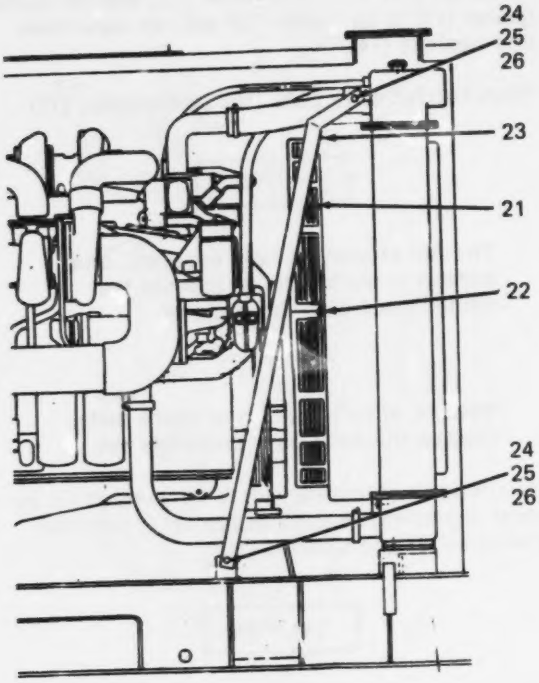
2-48. FAN HUB AND BRACKET REPLACE (CONT)

10 Install fan guard (21) using eight screws, washers, and lockwashers (22).

NOTE

Rotate fan guard so that open area faces downward.

11 Install radiator bracket (23) using screws (24), washers (25), and nuts (26).



2-49. IDLER ASSEMBLY REPAIR/REPLACE

This task covers: a. Inspection b. Removal c. Repair d. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Snap ring pliers (Item 2, Appendix B)

Equipment Condition Reference	Condition Description
Paragraph 2-41	Water pump drive belt removed

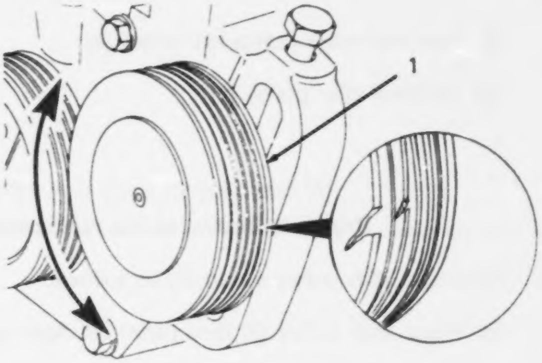
INSPECTION:

1 Visually inspect idler pulley (1) assembly for the following:

(a) Freedom of rotation.

(b) Cracked, chipped, or broken pulley grooves.

2 Repair or replace idler pulley assembly if it does not rotate freely or if damage is found.

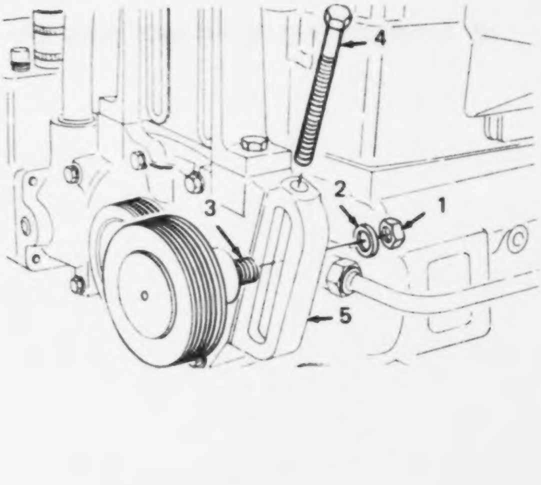


REMOVAL:

1 Remove nut (1) and washer (2) from back of idler pulley shaft (3).

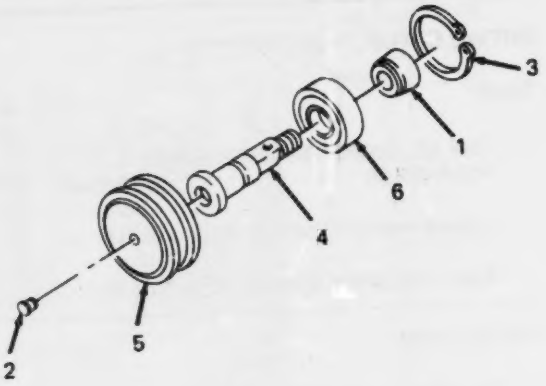
2 Remove adjusting screw (4).

3 Remove idler pulley from water pump body (5).



2-49. IDLER ASSEMBLY REPAIR/REPLACE (CONT)

REPAIR:



1 Disassemble idler pulley assembly as follows:

(a) Remove the water pump idler spacer (1).

(b) Remove pipe plug (2).

(c) Remove snap ring (3).

(d) Using punch tap idler shaft (4) from idler pulley (5).

(e) Using a brass drift punch remove ball bearing (6).

(f) Remove water pump idler shaft (4).

(g) Remove idler pulley (5).

NOTE

Repair is limited to the replacement of damaged or faulty parts.

2 Assemble idler pulley assembly as follows:

(a) Place idler pulley (5) face down on clean surface.

(b) Place water pump idler shaft (4) in position.

(c) Tap ball bearing (6) onto shaft and secure with snap ring (3).

(d) Install pipe plug (2) and water pump idler spacer (1).

2-49. IDLER ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:

1 Install idler pulley (1) in water pump body (2).

2 Install washer (3) and nut (4) on back of idler pulley shaft (5).

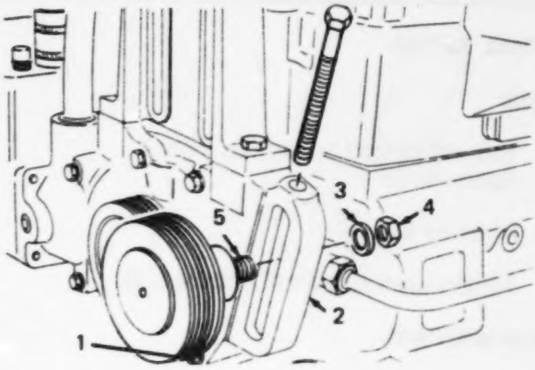
NOTE

Do not tighten nut (4) until the water pump drive belt has been installed and adjusted.

3 Install adjusting screw in idler pulley shaft.

4 Install water pump drive belt assembly in accordance with paragraph 2-41.

5 After belt assembly is adjusted tighten nut (4) to 45 to 55 ft-lbs (61 to 75 N•m) torque.



NOTE

Belt tension should be checked again after you have torqued nut (4).

2-50. WATER PUMP ASSEMBLY REPLACE

This task covers: a. Removal b. Installation c. Pressure Test

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Pressure tester

Torque wrench (Item 2, Appendix B)

Materials/Parts

Gasket connection

Gasket water pump

O-ring

Grease (Item 14, Appendix C)

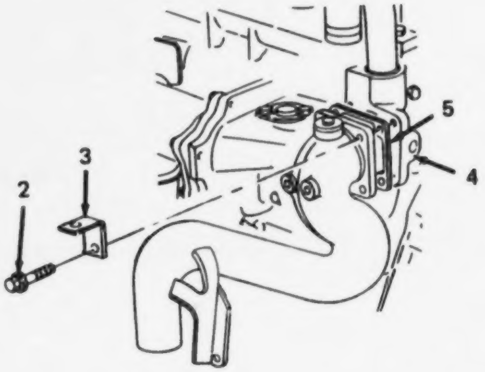
Equipment Condition Reference	Condition Description
Paragraph 2-35	Radiator assembly drain
Paragraph 2-41	Drive belt removed
Paragraph 2-48	Fan hub and bracket removed
Paragraph 2-49	Idler assembly removed
Paragraph 2-45	Water bypass tube removed

REMOVAL:

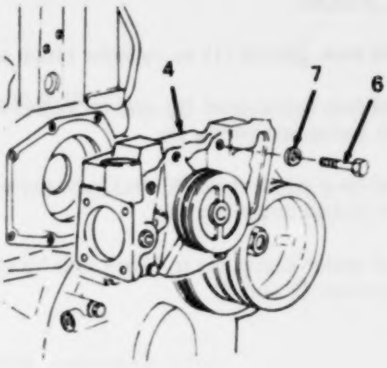
1 Remove water inlet connection (1) as follows:

(a) Remove four capscrews and lockwashers (2) and bracket (3) from water inlet connection (1).

(b) Separate inlet connection (1) from water pump (4) and remove and discard gasket (5).



2-50. WATER PUMP ASSEMBLY REPLACE (CONT)



2 Remove six mounting capscrews (6) and lockwashers (7) from water pump assembly (4).

3 Remove water pump (6) from the engine.

NOTE

The water pump must be removed carefully to prevent damage to the impeller.

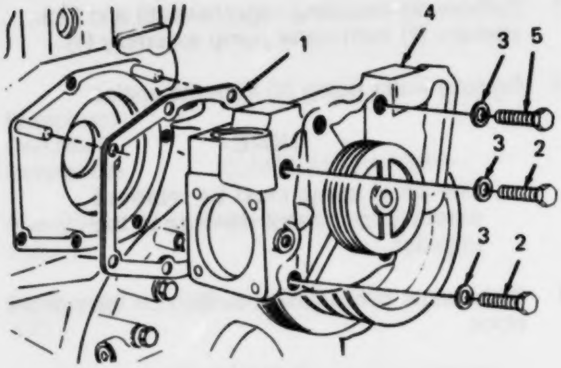
4 Clean water pump gasket surface on the cylinder block.

NOTE

Notify direct support maintenance for further repair and disassembly.

2-50. WATER PUMP ASSEMBLY REPLACE (CONT)

INSTALLATION:



1 Install new gasket (1) to cylinder block assembly.

2 Install two capscrews (2) and lockwashers (3) into water pump assembly (4).

3 Install four capscrews (5) and lockwashers (3) into water pump assembly (4).

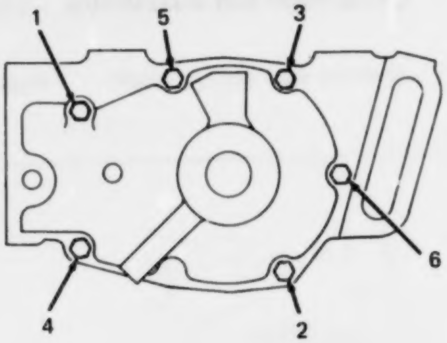
4 Install water pump (4) to block and hand tighten capscrews (2 and 5).

5 Tighten capscrews (2 and 5) in the sequence shown to the following torque values:

10 ft-lbs (15 N•m)

20 ft-lbs (30 N•m)

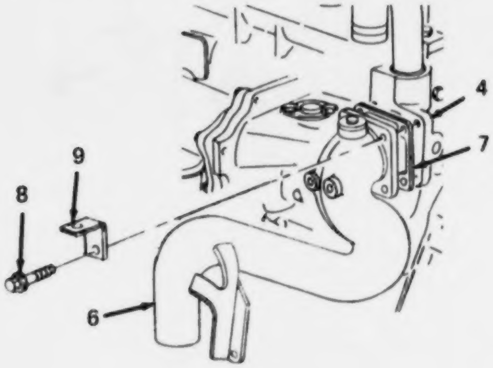
35 ft-lbs (45 N•m)



6 Install water inlet connection (6) as follows:

(a) Install new gasket (7) and position water inlet connection (6) on water pump (4).

(b) Install four capscrews and lockwashers (8) and bracket (9) and tighten to 35 ft-lbs (45 N•m) torque.



2-50. WATER PUMP ASSEMBLY REPLACE (CONT)

7 Install water bypass tube in accordance with paragraph 2-45.

8 Install idler pulley assembly in accordance with paragraph 2-49.

9 Install fan hub and bracket assembly in accordance with paragraph 2-48.

10 Install drive belts in accordance with paragraph 2-41.

11 Fill cooling system in accordance with paragraph 2-35.

PRESSURE TEST:

NOTE

Pressure test the system in accordance with paragraph 2-35.

2-51. FUEL FILTER ASSEMBLY SERVICE/REPAIR/REPLACE

This task covers: a. Service b. Removal c. Inspection/Repair d. Installation e. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Filter wrench (Item 2, Appendix B)

Materials/Parts

Fuel filter cartridges

Lint free cloth (Item 19, Appendix C)

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area, away from open flame, required for diesel fuel.

SERVICE:

NOTE

Turn fuel supply and return valves off prior to removing fuel filters.

1 Remove two fuel filter cartridges (1). Using filter wrench, rotate counterclockwise to remove. Discard cartridges.

2 Install fuel filters as follows:

WARNING

Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

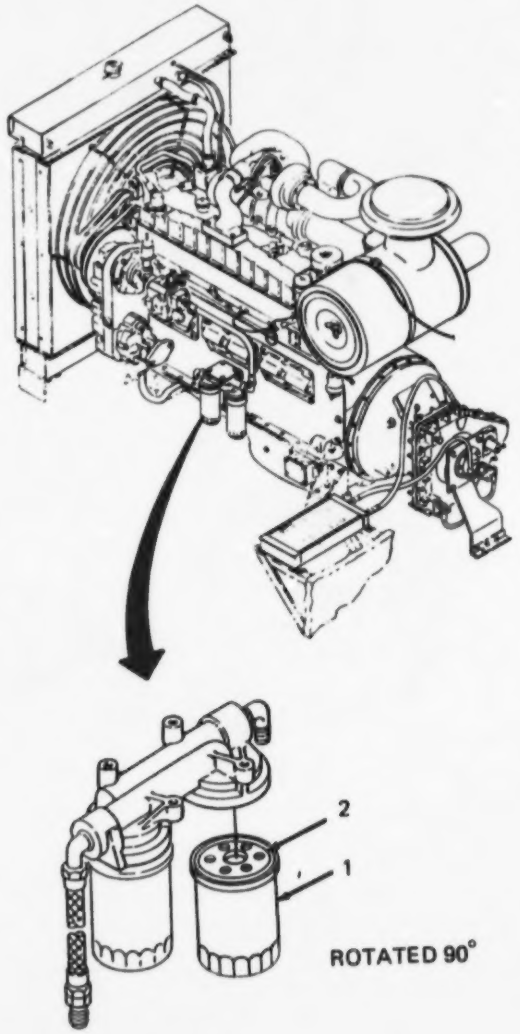
(a) Use a clean, lint-free towel to clean filter head gasket surface.

(b) Apply a light film of clean engine oil to filter gasket surface (2).

(c) Fill filters with clean fuel.

(d) Install filter on filter head. Tighten filter until gasket contacts filter head surface.

(e) Tighten filter an additional 1/2 to 3/4 turn after gasket contacts filter head surface.



2-51. FUEL FILTER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

REMOVAL:

1 Remove two fuel filter cartridges (1). Using a filter wrench, rotate counterclockwise to remove.

2 Disconnect fuel inlet line union (2) from male elbow (3).

3 Remove male elbow (3) from fuel filter head (4).

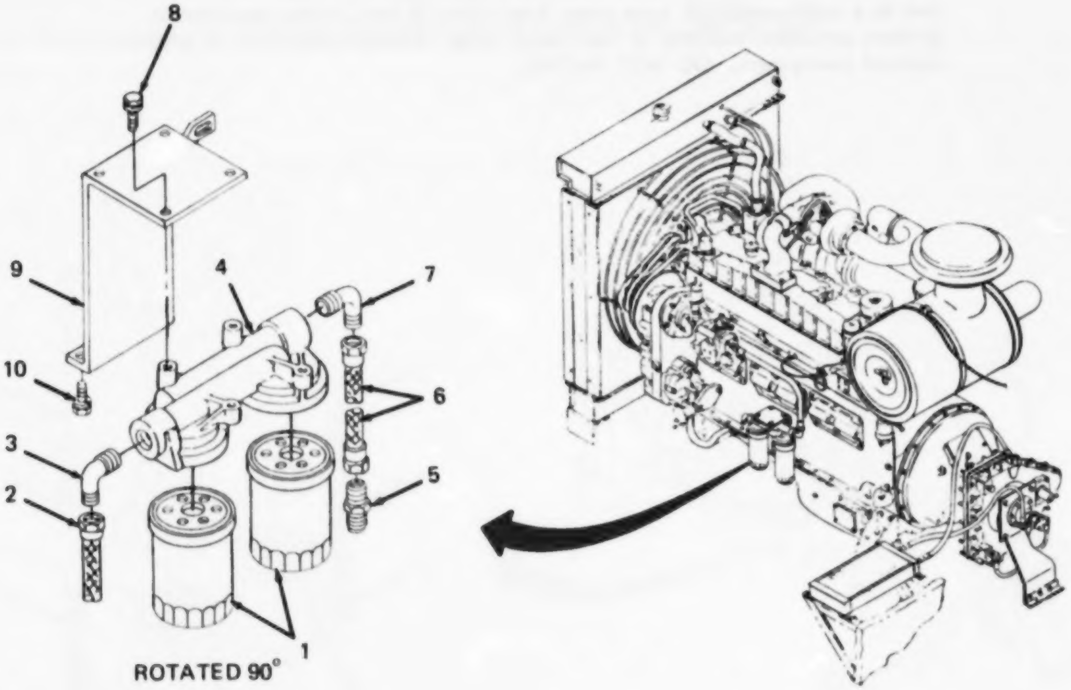
4 Remove male union (5) from fuel pump.

5 Remove flexible hose (6) from union (5) and male elbow (7).

6 Remove male elbow (7) from fuel filter head (4).

7 Remove four captive capscrews and lockwashers (8) and remove fuel filter head (4) from filter bracket (9).

8 Remove filter bracket (9) from engine by removing two captive screws and lockwashers (10).



2-51. FUEL FILTER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

INSPECTION/REPAIR:

1 Visually inspect inside of flexible hose and hose seating surface. If inner lining of hose has separated from center hose section, replace hose.

2 Check housing and fittings for cracks or signs of excessive corrosion or damage.

NOTE

Repair of fuel filter assembly components is limited to replacement of damaged or faulty parts.

INSTALLATION:

WARNING

Death or serious injury could occur if diesel fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

2-51. FUEL FILTER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

1 Position filter bracket (1) on engine and install two captive screws and lockwashers (2).

2 Position fuel filter head (3) under filter bracket (1). Install four captive capscrews and lockwashers (4) and secure head (3) to bracket (1).

3 Install male elbow (5) to filter head (3).

4 Install union (6) into fuel pump.

5 Install flexible hose (7) to union (6) and male elbow (5).

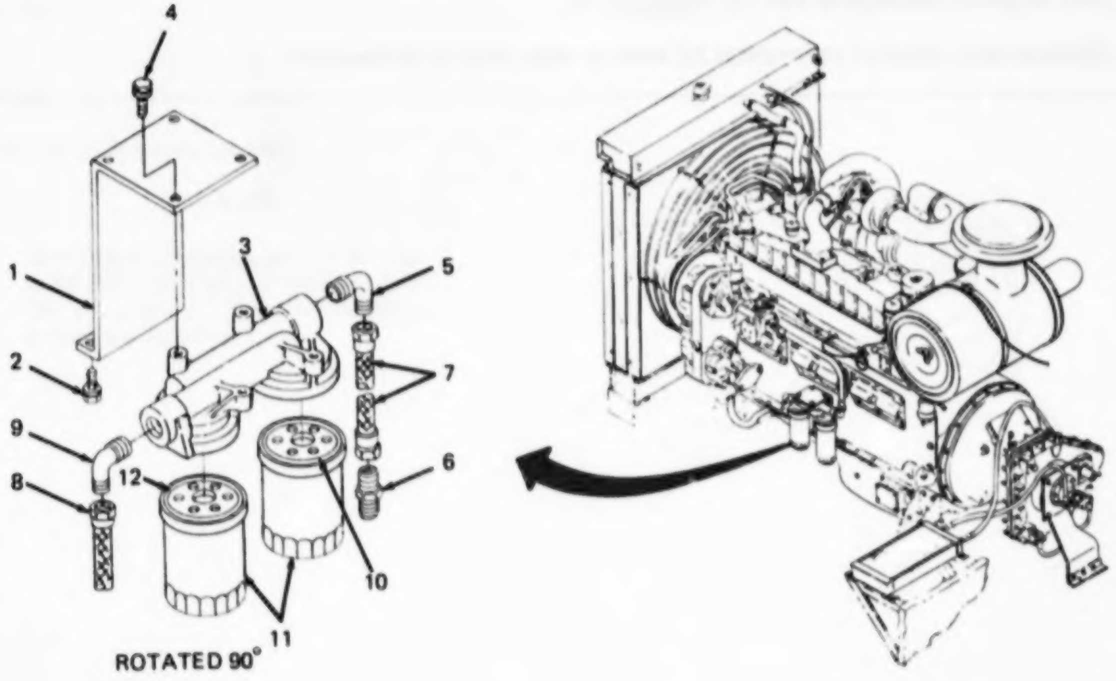
6 Install fuel inlet line union (8) to male elbow (9).

7 Apply a light film of clean oil to filter gaskets surfaces (10).

8 Fill filters (11) with clean fuel.

9 Install filters (11) on filter head (3). Tighten filter until gasket contacts filter head surface.

10 Tighten filter an additional 1/2 to 3/4 turn after gasket contacts filter head surface.



2-51. FUEL FILTER ASSEMBLY SERVICE/REPAIR/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsineus, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Observe newly installed components for leaks or other obvious malfunctions.

2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE

This task covers: a. Service b. Removal c. Cleaning/Inspection d. Installation e. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Filter wrench (Item 2, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Grease (Item 14, Appendix C)

Dry cleaning solvent (Item 30, Appendix C)

Gaskets

O-rings

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-38	Air cleaner air tube sections removed
Paragraph 2-35	Radiator assembly drain

General Safety Instructions

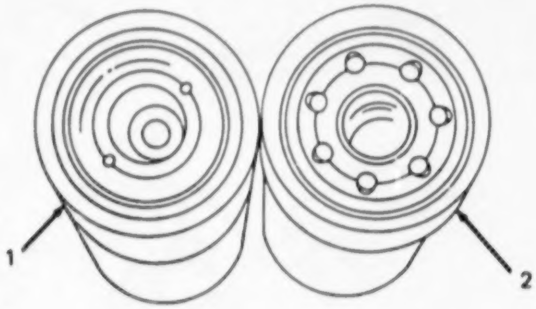
Well ventilated area required for cleaning and testing.

SERVICE:

1 Remove oil filters as follows:

NOTE

The external appearance of the by-pass filter (1) and the full flow filter (2) is the same. The internal differences are as shown.



2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

(a) Using oil filter wrench, remove bypass filter (1) and full flow filter (2).

(b) Clean oil filter head surface.

2 Install oil filters as follows:

(a) Use clean oil to lubricate gasket surface of filters.

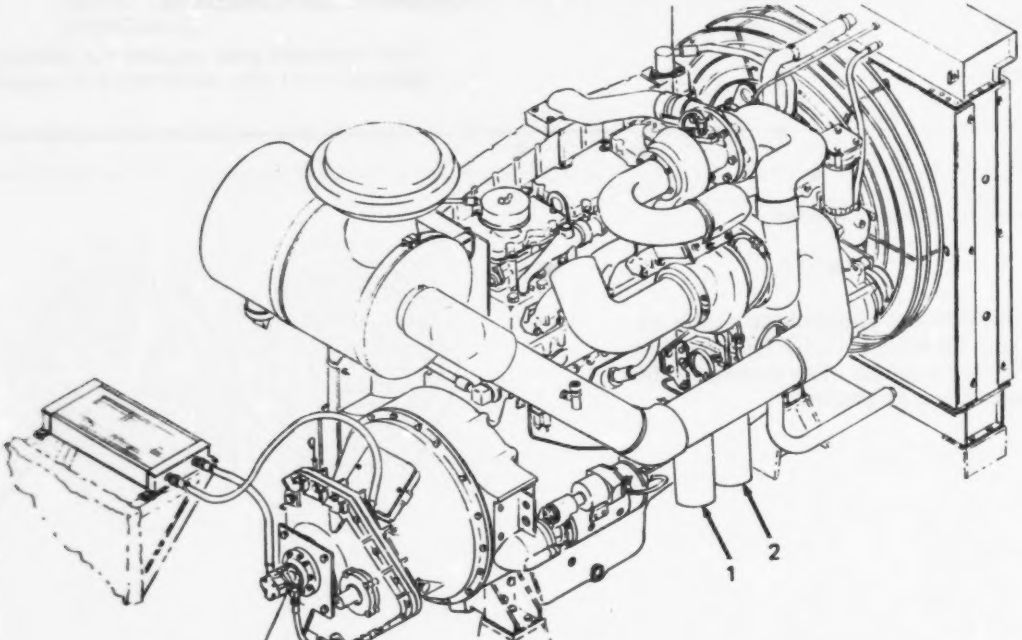
(b) Fill filters with clean oil.

CAUTION

Mechanical overtightening may distort the threads or damage the filter element seal.

(c) Install filters on oil filter head. Tighten filters until gasket contacts filter head surface.

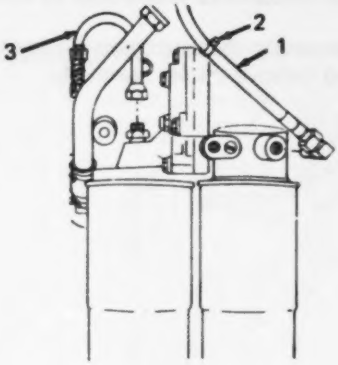
(d) Use oil filter wrench to tighten filters an additional 3/4 to 1 turn.



2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

REMOVAL:

1 Remove turbocharger oil supply tube (1), bracket (2), and bypass filter return tube (3).



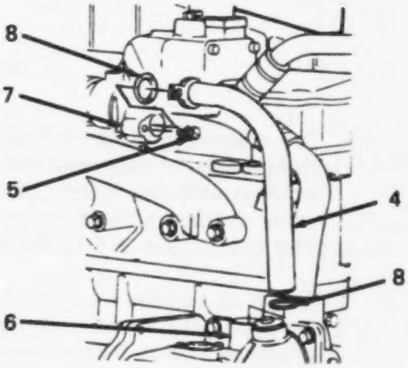
2 Remove water transfer tube (4) as follows:

   (a) Remove one capscrew, washer, and lockwasher (5).

   (b) Remove water transfer tube (4) from oil cooler support (6) and water manifold (7).

   (c) Remove and discard two O-rings (8).

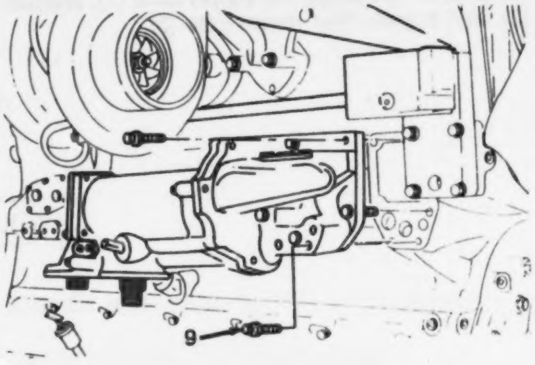
3 Remove full flow filter and bypass filter.



2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

4 Remove two capscrews which hold oil cooler brace to cylinder block at rear of cooler.

5 Remove remaining six capscrews (9) from oil cooler support and remove cooler assembly.



CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean gasket material from cooler support and cylinder block.

2 After removing gasket material, use dry cleaning solvent and dry with compressed air.

3 Inspect lubrication oil filter/cooler for obvious damage.

NOTE

Notify direct support maintenance for further repair and disassembly.

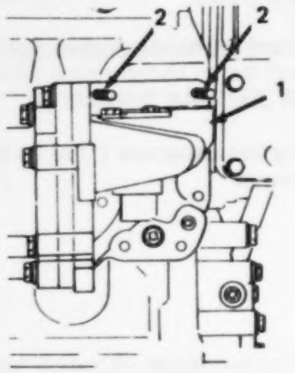
2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

INSTALLATION:

1 Install two guide studs in oil cooler support mounting holes in cylinder block.

2 Install new oil cooler support gasket over guide studs.

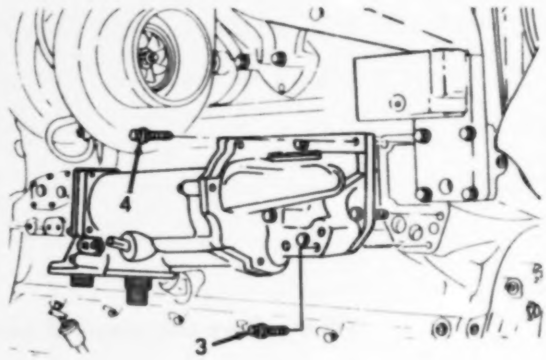
3 Install oil cooler assembly (1) over guide studs (2) and push it against cylinder block.



4 Install two oil cooler brace capscrews. Do not tighten at this time.

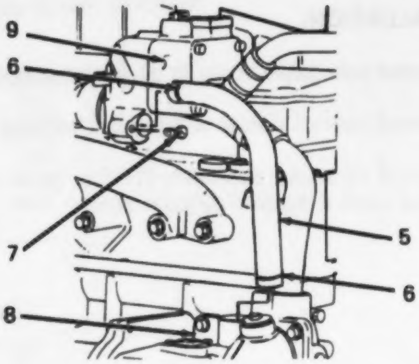
5 Install four support mounting capscrews (3) and remove two guide studs.

6 Install two remaining capscrews (4) and tighten all support capscrews to 35 ft-lbs (45 N-m) torque.



7 Tighten two cooler brace mounting capscrews to 8 ft-lbs (10 N-m) torque.

2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

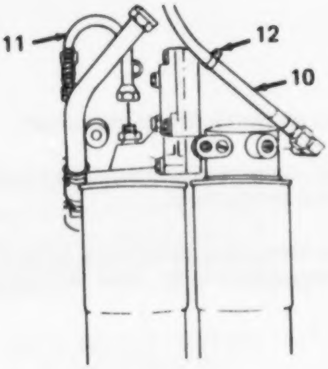


8 Install water transfer tube (5) as follows:

(a) Coat two new O-rings seals (6) with GAA grease and install.

(b) Insert capscrew, lockwasher, and washer (7) and fasten transfer tube (5) to oil cooler support (8) and water manifold (9).

(c) Tighten capscrew (7) to 20 ft-lbs (25 N m) torque.



9 Install turbocharger oil supply tube (10) and bypass filter return tube (11).

10 Install bracket (12).

NOTE

Fill the filters with clean oil before installing them.

11 Install full flow filter and bypass filters.

12 Install air cleaner air tube sections in accordance with paragraph 2-38.

13 Fill cooling system in accordance with paragraph 2-35.

2-52. LUBRICATION OIL FILTER/COOLER SERVICE/REPLACE (CONT)

OPERATIONAL CHECK:

1 Start engine in accordance with TM 5-4320-307-10 and observe installed components for looseness and rattles. Tighten as required.

2 Operate engine until water temperature reaches 180°F (80°C) and check for oil and coolant leaks.

2-53. ROCKER LEVER COVER ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Material/Parts

Gaskets

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-47	Aftercooler air crossover connection removed

General Safety Instructions

Well ventilated area required for cleaning and testing.

REMOVAL:

1 Remove two clamps and plain hose from crankcase breather assembly.

2 Remove five capscrews and washers from each rocker lever cover.

3 Remove covers.

CLEANING/INSPECTION/REPAIR:

1 Remove crankcase breather and oil filler cap.

2 Remove all gaskets.

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

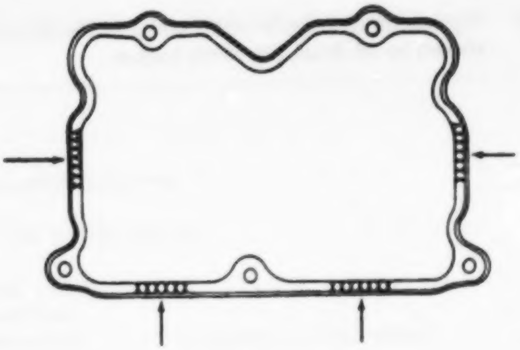
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protection equipment.

3 Steam clean covers and dry with compressed air.

2-53. ROCKER LEVER COVER ASSEMBLY REPAIR/REPLACE (CONT)

NOTE

Stamped steel valve covers are designed and manufactured with a 0.030-inch (0.75 mm) bow located in the shaded areas as shown to provide better sealing qualities. This built-in bow on the valve covers must not be mistaken for warpage. Also, do not attempt to increase or remove the bow from the sealing surface.



4 Inspect each cover for cracks or damage.

NOTE

Repair of rocker lever assembly components is limited to the replacement of damaged or faulty parts.

INSTALLATION:

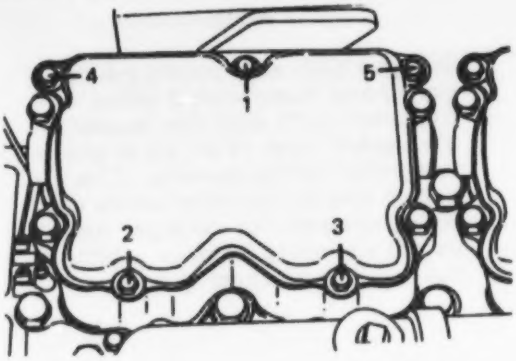
1 Install new gasket on each rocker lever housing.

2 Install covers on rocker lever housings.

3 Install five capscrews and washers in each cover.

2-53. ROCKER LEVER COVER ASSEMBLY REPAIR/REPLACE (CONT)

4 Tighten capscrews in each cover in the sequence shown to 15 ft-lbs (20 N·m) torque.



5 Install aftercooler air crossover connection in accordance with paragraph 2-47.

6 Install plain hose on crankcase breather assembly. Install two hose clamps and tighten.

2-54. ROCKER LEVER ADJUST

This task covers: a. General b. Crosshead Valve Adjustment c. Rocker Lever Valve Adjustment d. Operational Check

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Gaskets

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-53	Rocker lever cover assembly removed

GENERAL:

NOTE

All crosshead valve adjustments must be made when the engine is cold (any stabilized coolant temperature at 140°F (60°C) or below).

Insure the rocker housing capscrews are tightened to 60 ft-lbs (80 N·m) torque.

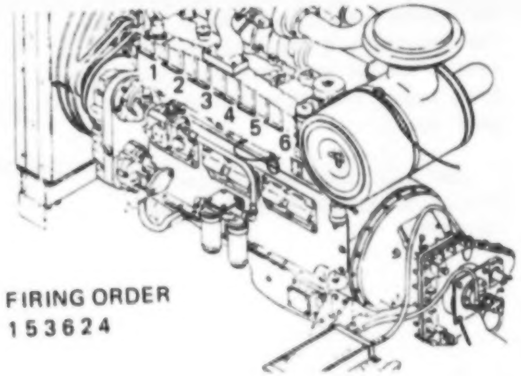
The valve set marks are located on the accessory drive pulley. The marks align with a pointer on the gear cover.

Use the accessory drive shaft to rotate the crankshaft.

The crankshaft rotation is clockwise when viewed from the front of the engine.

The cylinders are numbered from the front gear cover end of the engine.

The engine firing order is 1-5-3-6-2-4.

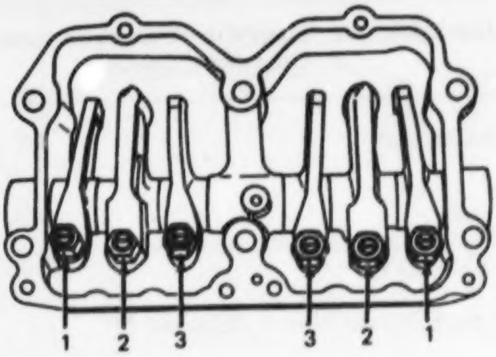


2-54. ROCKER LEVER ADJUST (CONT)

NOTE

Each cylinder has three rocker levers. The rocker lever nearest to the center of the housing is the intake lever.

- The exhaust rocker lever (1).
- The injector rocker lever (2).
- The intake rocker lever (3).



The valves and the injectors on the same cylinder are not adjusted at the same index mark on the accessory drive pulley.

One pair of valves and one injector are adjusted at each pulley index mark before rotating the accessory drive to the next index mark.

Two crankshaft revolutions are required to adjust all the valves and the injectors.

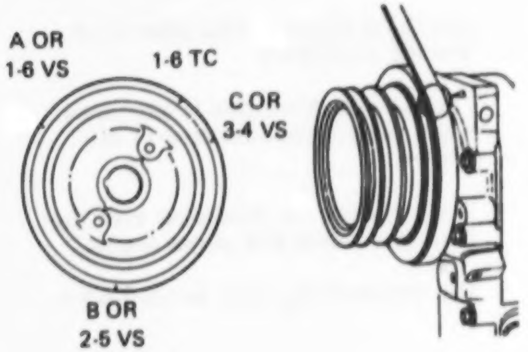
Injector and Valve Adjustment Sequence

Bar Engine in Direction of Rotation	Pulley Position	Set Cylinder Injector	Set Cylinder Valve
Start	A	3	5
Advance to	B	6	3
Advance to	C	2	6
Advance to	A	4	2
Advance to	B	1	4
Advance to	C	5	1

Firing Order: 1-5-3-6-2-4

After adjusting the crossheads and the valves on cylinder No. 5, rotate the accessory drive; and align the next valve set mark on the accessory drive pulley with the pointer on the gear cover.

Repeat this process to adjust all injectors, crossheads, and valves correctly.



2-54. ROCKER LEVER ADJUST (CONT)

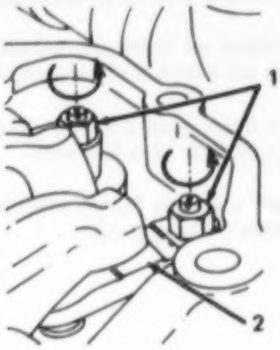
CROSSHEAD VALVE ADJUSTMENT:

NOTE

Crosshead valve adjustment must always be made before attempting to adjust the rocker lever valves.

1 Align A valve set mark with pointer on gear cover.

2 With both valves closed on cylinder No. 5, loosen crosshead adjusting screw locknuts (1) on intake and exhaust valve crossheads (2) for cylinder No. 5.



NOTE

The following procedures are used to adjust both the intake and the exhaust crossheads.

3 Turn adjusting screw out at least one turn.

4 Hold crosshead down against its mating valve stems.

5 Turn adjusting screw in until it touches top of valve stem but does not raise crosshead. Hold adjusting screw in this position.

NOTE

The adjusting screw must not turn when locknut is tightened to its torque value.

2-54. ROCKER LEVER ADJUST (CONT)

6 Tighten locknut to 30 ft-lbs (40 N-m) torque.

7 Adjust intake and exhaust valves on No. 5 cylinder before rotating accessory drive to next valve set mark.

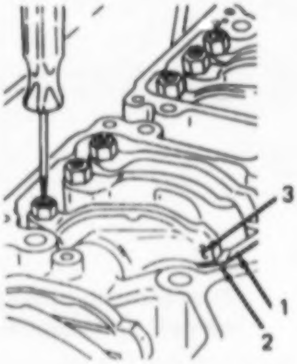
8 Continue adjustments until all crosshead valves have been adjusted.

ROCKER LEVER VALVE ADJUSTMENT:

1 With A valve set mark aligned with pointer on gear cover and both valves closed on cylinder No. 5, loosen locknuts on intake and exhaust valve adjusting screws.

2 Select a feeler gauge for the correct valve lash specification (intake valve 0.011-inch or 0.028 mm, exhaust valve 0.023-inch or 0.058 mm).

3 Insert feeler gauge (1) between top of crosshead (2) and rocker lever pad (3).



4 Tighten adjusting screw until a slight drag is felt on feeler gauge.

2-54. ROCKER LEVER ADJUST (CONT)

5 Hold adjusting screw in this position. The adjusting screw **must not** turn when locknut is tightened. Tighten locknut to 45 ft-lbs (60 N m) torque.

NOTE

After tightening locknut to the correct torque value, check to make sure the feeler gauge will slide backward and forward between the crosshead and the rocker lever with only a slight drag.

6 Continue adjustment until all rocker lever valves have been adjusted.

7 Install rocker lever cover assembly in accordance with paragraph 2-53.

OPERATIONAL CHECK:

WARNING

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Observe newly adjusted components for proper operation.

2-55. OIL DRAIN ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-36	Engine oil drained

General Safety Instructions

Well ventilated area required for cleaning.

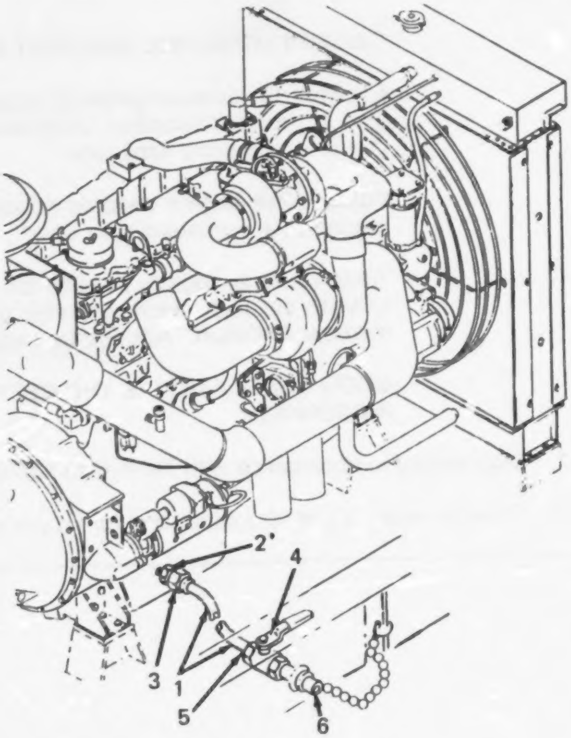
REMOVAL:

1 Disconnect lube oil drain hose (1) from nipple (2) by unscrewing hose fitting (3).

2 Disconnect hose (1) from drain valve (4) by unscrewing hose fitting (5).

3 Remove nipple (2) from engine oil pan.

4 Remove drain valve (4) from drain fitting (6).



2-55. OIL DRAIN ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

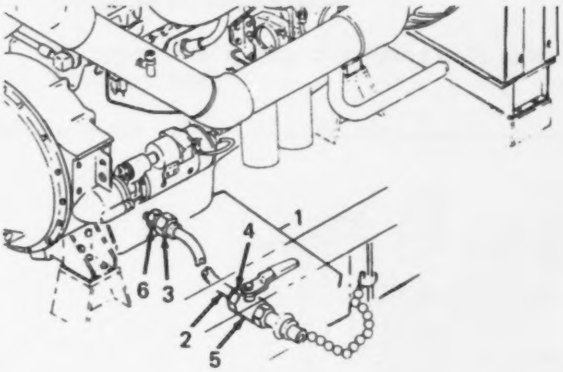
1 Clean oil drain assembly (1) with dry cleaning solvent.

2 Inspect lube oil drain hose (2) for damage and see that hose is secure in hose fittings (3 and 4). Check threads on hose fittings for damage.

NOTE

Repair is limited to the replacement of damaged components.

3 Replace lube oil drain hose (2) if damaged or if more than 25% of the threads on either fitting (3 and 4) is lost due to damage.



NOTE

The lube oil drain hose and hose fittings are provided as an assembly.

4 Replace drain valve (5) if external damage or damaged threads are present or if leakage was previously observed from valve.

5 Replace nipple (6) if external damage or damaged threads are present or if leakage was previously observe from nipple.

2-55. OIL DRAIN ASSEMBLY REPAIR/REPLACE (CONT)

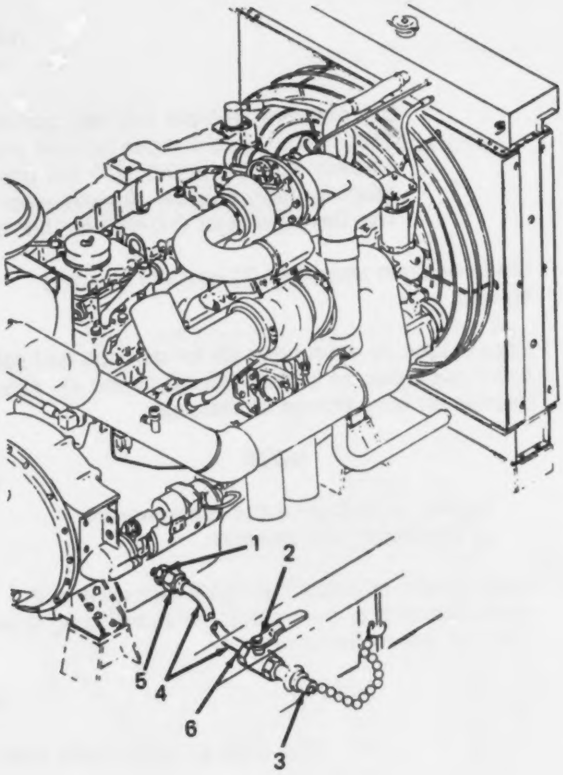
INSTALLATION:

1 Install nipple (1) to engine oil pan.

2 Install drain valve (2) to drain fitting (3).

3 Install hose (4) by tightening hose fitting (5) on nipple (1) and hose fitting (6) to drain valve (2).

4 Replace engine lube oil in accordance with paragraph 2-36.



2-56. SUCTION AND DISCHARGE COVER REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Emery cloth (Item 2, Appendix C)

Personnel Required

Two

General Safety Instructions

Area must be well ventilated.

No open flame, sparks, or smoking while using cleaning solvent.

REMOVAL:

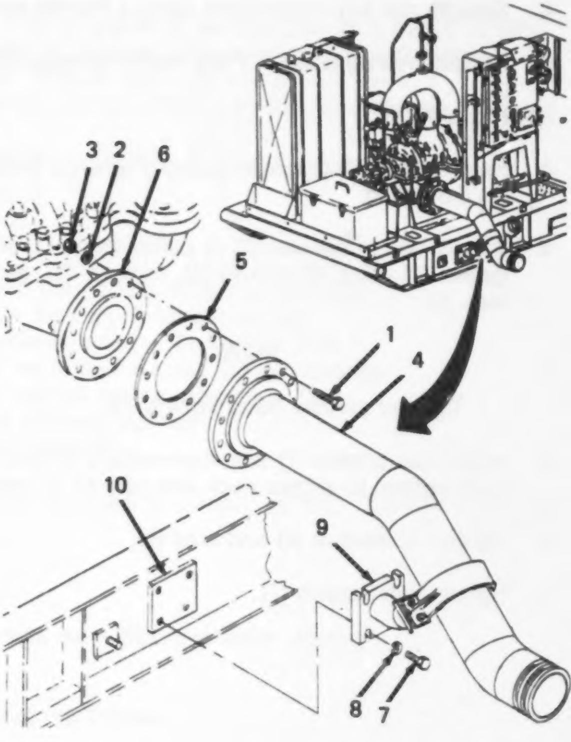
NOTE

The removal of the suction and discharge nozzle adapters are identical. Only the discharge nozzle removal is presented.

1 Remove 12 screws (1), washers (2), and nuts (3) that secure discharge nozzle adapter (4) and gasket (5) to pump discharge flange (6).

2 Remove four screws (7) and washers (8) that secure neck and pipe (9) to mounting plate (10) on skid.

3 If nozzle adapter is not to be installed immediately, install blind flange on discharge flange (6).



2-56. SUCTION AND DISCHARGE COVER REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

1 Clean flange end and grooved end of nozzle adapter using dry cleaning solvent.

2 Clean pump flange using cleaning solvent.

3 Inspect flange and grooved end of nozzle adapter for burrs, dents, pitting, or other damage.

4 Smooth out any minor burrs using a fine file and emery cloth.

5 Replace nozzle adapter if any major damage is present which could cause leakage.

INSTALLATION:

1 Remove blind flange from pump discharge flange (1) if installed.

2 Secure nozzle adapter (2) to pump flange (1) with gasket (3) using 12 screws (4), washers (5), and nuts (6).

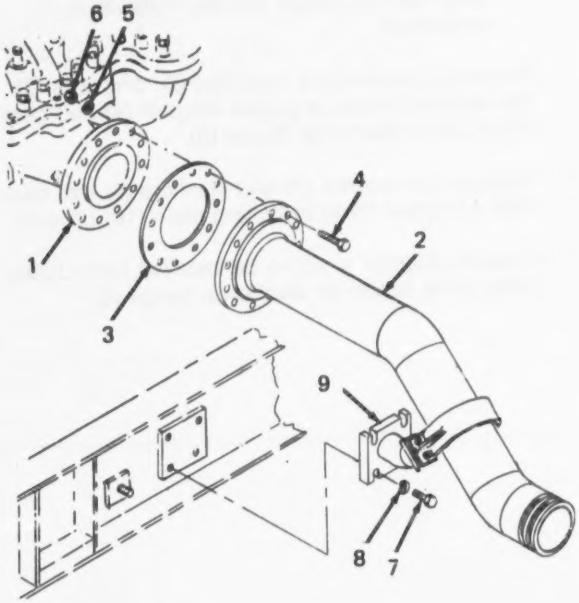
NOTE

Tighten screws hand tight only.

3 Install four screws (7) with lockwashers (8) and hand tighten to secure neck and pipe (9) to skid.

4 Tighten 12 screws (4) and nuts (6).

5 Tighten four screws (7).



Section VII. PREPARATION FOR STORAGE OR SHIPMENT

2-57. GENERAL

This section provides instructions for preparing the pumping assembly for short term and long term storage or shipment.

2-58. ADMINISTRATIVE STORAGE

Administrative storage shall be in accordance with AR 750-1.

2-59. SHORT TERM STORAGE (30 days or less)

NOTE

When the pumping assembly is taken out of service, take special precautions to protect the interior and exterior of the unit from rust accumulation and corrosion.

The following instructions apply when the pumping assembly is to be placed in storage/idle for a period of not more than 30 days. Additional or supplementary measures may be directed to meet current or anticipated conditions such as extremes of temperature; exposure to dust, sand, or debris; or salt air such as in a beachhead location. These instructions do not apply to temporary shutdowns to relocate the pumping assembly.

WARNING

Severe burns, illness, or death could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.

a. Fill fuel tank with VV-F-800 diesel fuel. Connect pumping assembly to a water supply. Operate engine for 2 minutes at idle and no load.

NOTE

Do not drain the fuel system after the 2-minute run. Remove water supply after this run.

b. Prepare suction and discharge nozzle adapters for storage as follows.

2-59. SHORT TERM STORAGE (30 days or less) (CONT)

NOTE

The removal of the suction and discharge nozzle adapters are identical. Only the discharge nozzle removal is presented.

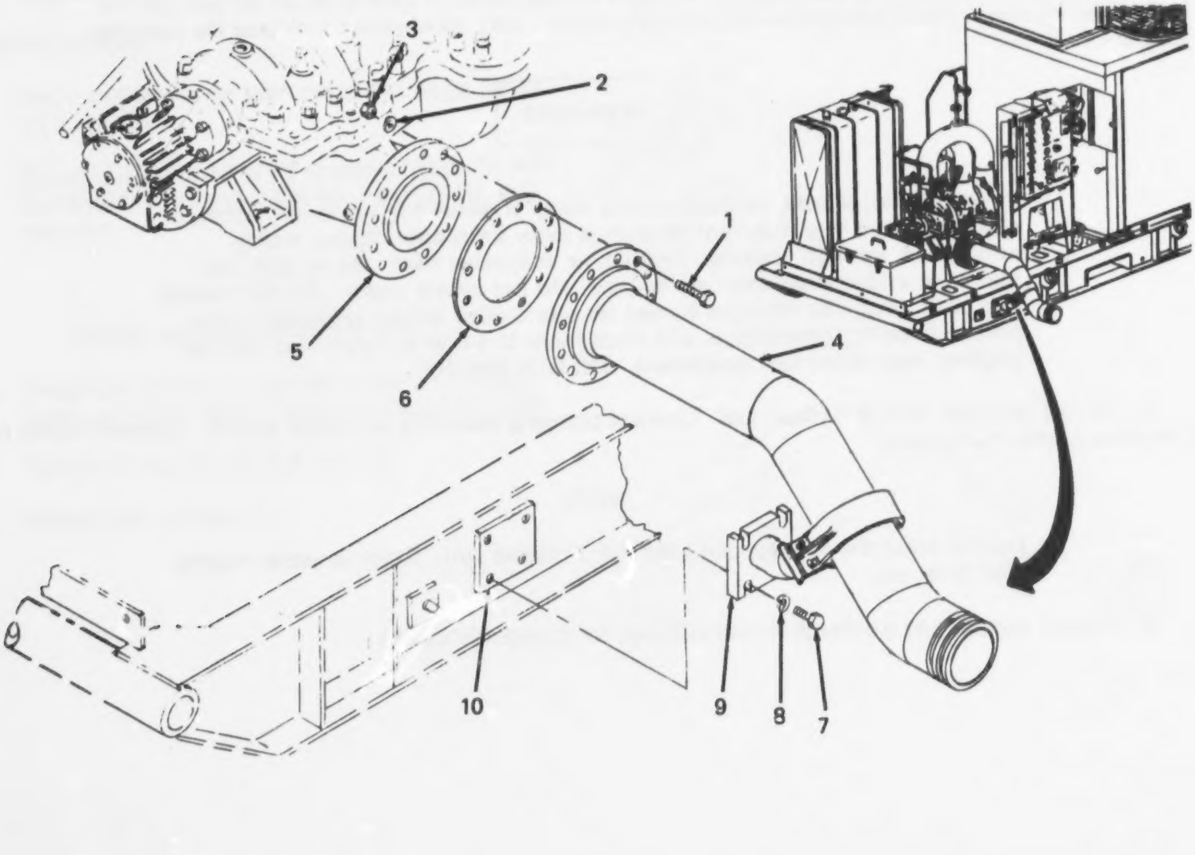
(1) Remove 12 screws (1), washers (2), and nuts (3) that secure nozzle adapter (4) to pump flange (5).

(2) Remove gasket (6).

(3) Remove four screws (7) and washers (8) that secure the nick and pipe (9) to mounting plate on skid (10).

(4) Install nozzle adapters (4) into their storage position.

(5) Install blind flanges on the pump suction and discharge ports.



2-59. SHORT TERM STORAGE (30 days or less) (CONT)

c. Prepare pump assembly for storage as follows:

(1) Place a suitable catch basin under pump drain plugs.

(2) Remove four pump drain plugs and drain pump. Place a tag indicating pump is preserved.

(3) Protect internal pump surfaces with a coating of preservative oil.

(4) Drain any excess oil from pump.

(5) Place waterproof tape between blind flange and pump flange and then secure blind flange to pump suction and discharge ports with four screws and four nuts.

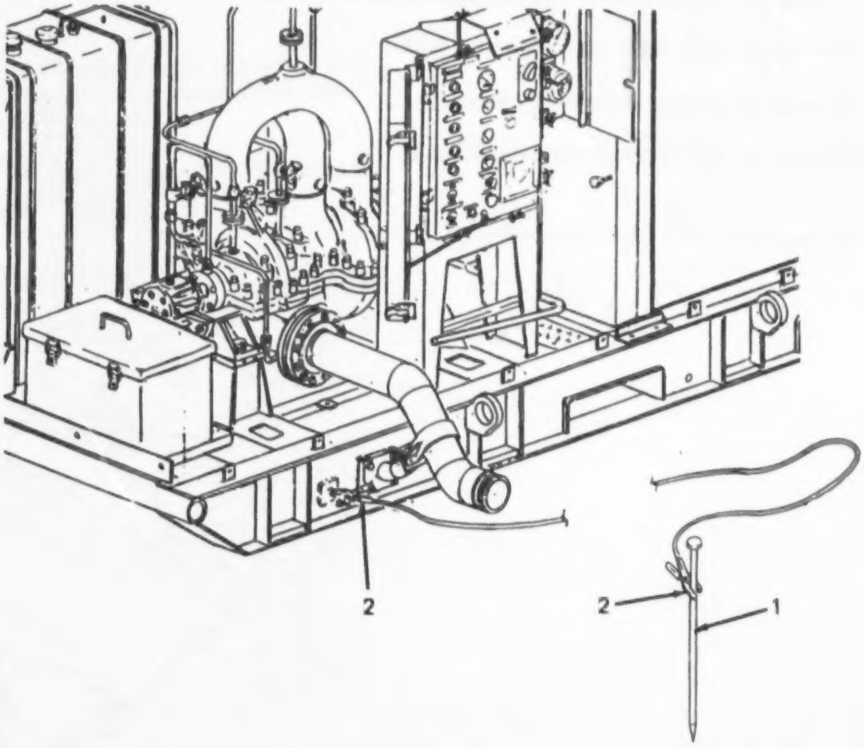
(6) Place plastic bags with mounting hardware and gaskets in storage box.

(7) Cover all surfaces of pump with protective film and fasten with pressure sensitive tape.

d. Change engine oil in accordance with lubrication instructions in paragraph 2-36.

e. Clean air cleaner assembly in accordance with paragraph 2-38.

f. Remove grounding rod (1) and clamps (2) and store horizontally in front portion of pumping assembly.



2-59. SHORT TERM STORAGE (30 days or less) (CONT)

g. Seal all engine openings with tape, strong enough to resist puncture and damage from the expansion of entrapped air.

h. For indoor and outdoor storage, cover entire unit with weather cover supplied with unit, tied or weighted to prevent movement.

2-60. INTERMEDIATE TERM STORAGE (More than 30 days)

The following instructions apply when the pumping assembly is to be placed in storage for a period greater than 30 days. Additional or supplementary measures may be directed to meet current or anticipated conditions such as extremes of temperature; exposure to dust, sand, or debris; or salt air such as in a beachhead location. These instructions do not apply to temporary shutdowns to relocate the pumping assembly.

NOTE

Procedure a., below, must be done with the assistance of direct support maintenance personnel.

a. Prepare engine crankcase for storage:

NOTE

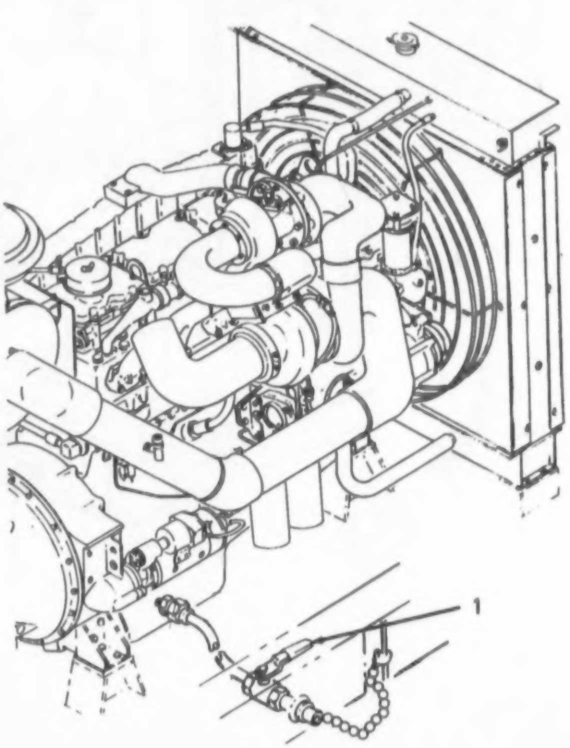
The following procedures are most effective when initiated as quickly as possible after the pumping assembly has been taken out of service with the engine still at or near normal operating temperatures.

(1) Turn 2 way drain valve (1) to open position.

(2) Once oil is drained, close 2-way valve (1).

(3) Replace oil filters in accordance with paragraph 2-52.

(4) Fill crankcase with clean lubricating oil.

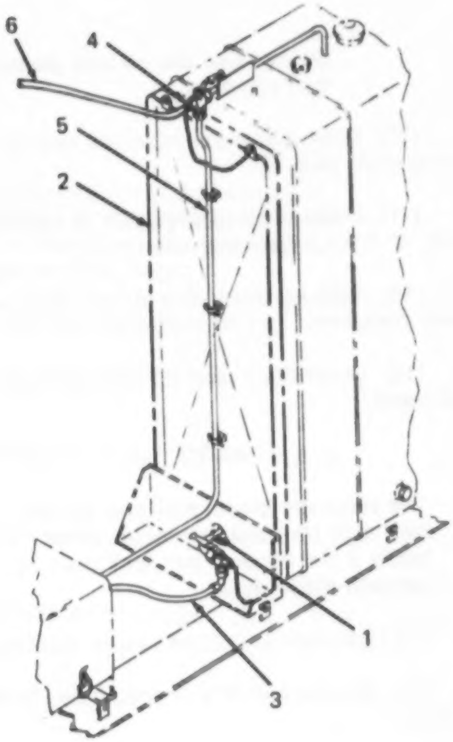


2-60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

b. Prepare fuel system for storage:

WARNING

Death or serious injury could occur if diesel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.



(1) Turn 3-way fuel supply valve (1) to OFF position to interrupt the connection between tank (2) and engine diesel fuel inlet pipe (3).

(2) Turn 3-way fuel return valve (4) to OFF position to interrupt the connection with diesel fuel return pipe (5).

NOTE

Use a portable two-section container holding 6.1 gallons of diesel fuel (VV-F-800 standard) in one section and 6.1 gallons of P-9 protective oil (conform to VV-L-800 TECTYL 900 TYPE) in the other.

(3) Using transparent tube (6) connected to 3-way fuel return valve AUX position, place diesel fuel return tube to a recovery container.

(4) Place 3-way fuel supply valve in AUX position and connect to fuel section of the portable container.

(5) Operate engine until normal operating temperatures are obtained.

2-60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

(6) Accelerate engine to 3/4 the rated speed, and at this point shift the supply line to the section holding protective oil.

(7) Run engine at the above speed until protective oil has flowed into the recovery container.

(8) Stop engine.

(9) Disconnect piping that was temporarily installed and place 3-way valves in OFF position.

CAUTION

Do not use the oil and diesel fuel mixture recovered to protect other diesel fuel systems.

(10) Drain diesel fuel from fuel tank (2) by removing drain plug (6).

(11) Install drain plug (6) and fill fuel tank with a capacity of 420:1 with preservative oil.

(12) Remove drain plug (6) and drain oil into a recovery container.

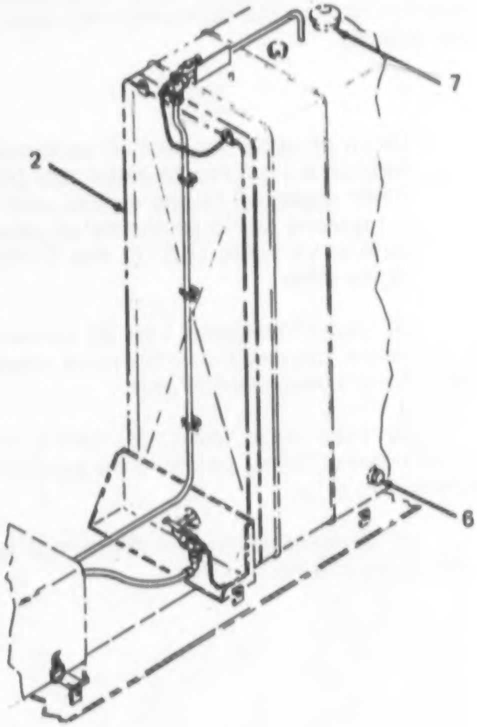
(13) Cover drain plug (6) with some protective oil and install.

NOTE

The recovery diesel fuel and oil mixture may be used to protect other tanks if the mixture has less than 10 percent diesel fuel.

(14) Seal off vent (7) with cloth reinforced tape.

(15) Service fuel filter in accordance with paragraph 2-51.



2-60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

c. Prepare V-belts for storage:

(1) Relieve V-belt tension.

(2) Insert slips of heavy brown paper between all pulleys and V-belts to prevent sticking.

(3) Adjust V-belt tension sufficiently to hold slips of paper in place.

(4) Place a red tag on the belts with the following wording "Belt tension relieved; adjust prior to star engine".

d. Prepare batteries for storage:

WARNING

Severe burns or blindness may result if battery electrolyte (acid) comes in contact with skin or eyes. When handling batteries or electrolyte, use eye protection. If acid is splashed on skin, wash immediately with clean water. If acid enters the eyes, flush with water and get medical help.

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

NOTE

Store batteries separately from pumping assembly in a cool, dry location at a temperature no lower than 32°F (0°C).

(1) Remove battery cover and insure all cell caps or covers are in place and accounted for. Insure battery connections are in accordance with label.

(2) Disconnect battery cables and remove battery. Clean battery and battery cables with a baking s solution. Do not allow solution to enter battery cells. Rinse battery and cables with clean, fresh water.

(3) Remove the cell caps or covers and check electrolyte solution level.

(4) Fill each cell with water if necessary.

(5) Store battery separately from pump unit in a cool, dry location at a temperature no lower than 32°F (0°C).

(6) Coat battery terminals and cables contact end with protective oil.

(7) Cover cables with polyester or cellulose acetate material, fastening it with cloth reinforced tape. openings against humidity.

(8) Install battery cover and snap closed.

60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

e. Prepare pump assembly for storage:

(1) Prepare suction and discharge nozzle adapters for storage in accordance with short term storage aragraph 2-59.

(2) Drain pump assembly in accordance with short term storage paragraph 2-59.

(3) Service pump in accordance with pump lubrication paragraph 2-25.

f. Prepare speed increaser for storage:

(1) Service speed increaser assembly in accordance with paragraph 2-3.

(2) Cover vent with cloth reinforced tape.

(3) Cover oil filling opening and all other openings with cloth reinforced tape.

2-60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

g. Prepare muffler and muffler guard for storage:

(1) Remove six screws (1), washers (2), lockwashers (3), and nuts (4) securing muffler guard (5) around muffler (6).

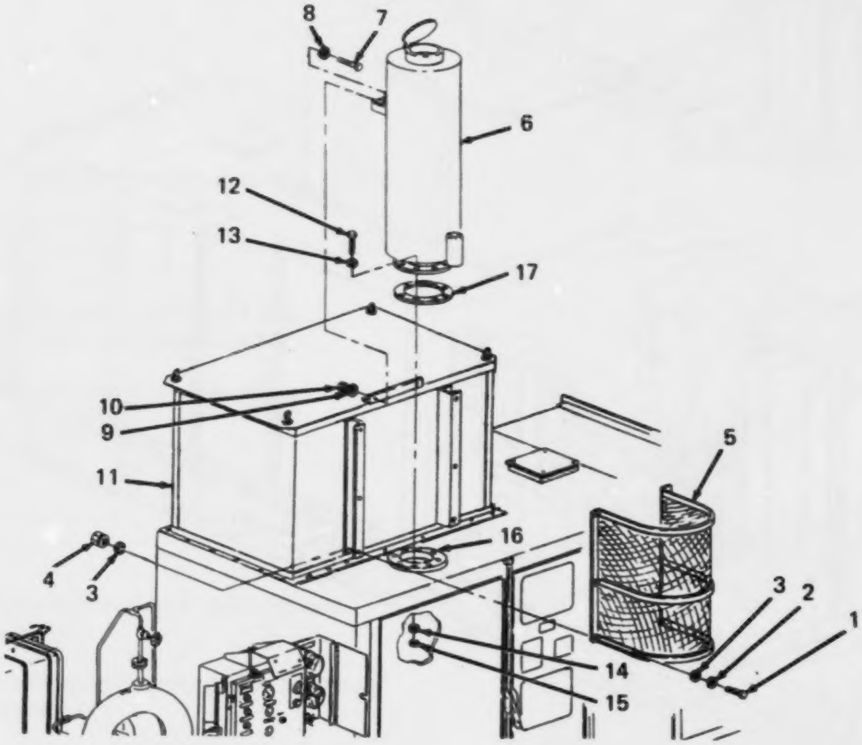
(2) Remove two secrews (7), washers (8), lockwashers (9), and nuts (10) securing muffler (6) to intake duct (11).

(3) Remove eight screws (12), washers (13), lockwashers (14), and nuts (15) securing muffler (6) to top of exhaust port (16).

WARNING

Muffler weighs 154 lbs (70 kg). Use suitable lifting device to prevent injury to personnel.

(4) Remove muffler (6). Discard gasket (17).



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60. INTERMEDIATE TERM STORAGE (More than 30 days) (CONT)

h. Prepare intake duct for storage:

WARNING

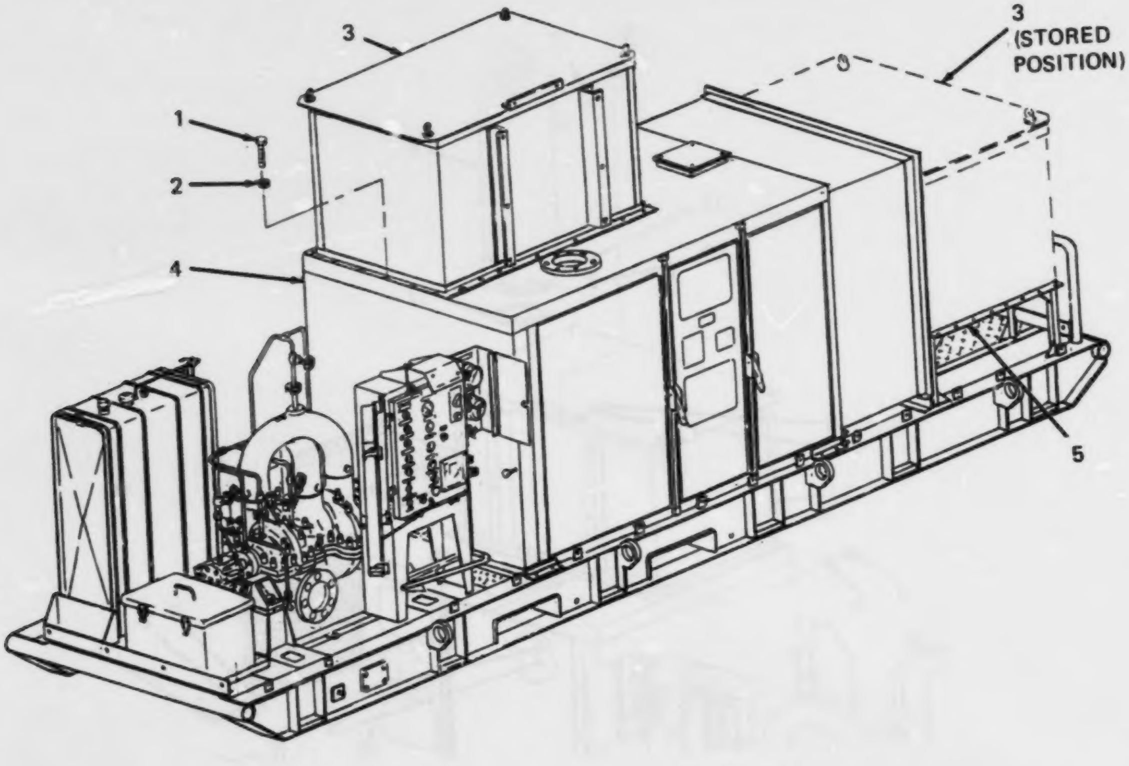
Intake duct weighs 275 lbs (124 kg). Use a suitable lifting device to prevent injury to personnel.

(1) Remove 24 screws (1) and lockwasher (2).

(2) Using a suitable lifting device, remove intake duct (3) from on top of engine closure (4) and air take port.

(3) Position air intake duct (3) onto storage rack (5) and install screws.

(4) Remove air cleaner rain cap and install in storage box.



2-61. PREPARATION FOR SHIPMENT

a. Prepare pumping assembly for intermediate storage (more than 30 days) in accordance with paragraph 2-60.

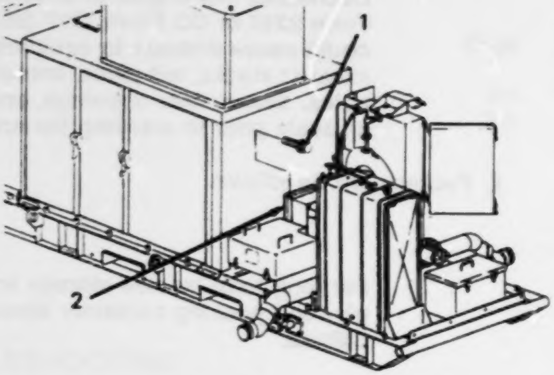
b. Cushion contents of toolbox with sufficient dunnage to prevent damage when pumping assembly is shipped.

c. Remove flexible coupling as follows:

NOTE

To avoid misalignments of the shafts during shipment, it is necessary to remove the power pack section of the flexible coupling.

(1) Remove four screws and washers (1) securing protective cover (2) to engine enclosure and remove cover.

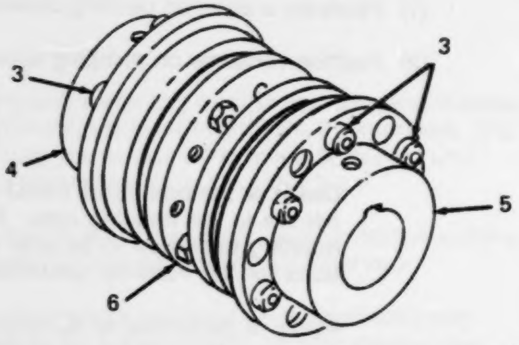


(2) Remove bolts (3) from standard hub (4) and hub (5).

CAUTION

Do not pry apart hub grooves as this may damage the machined surfaces.

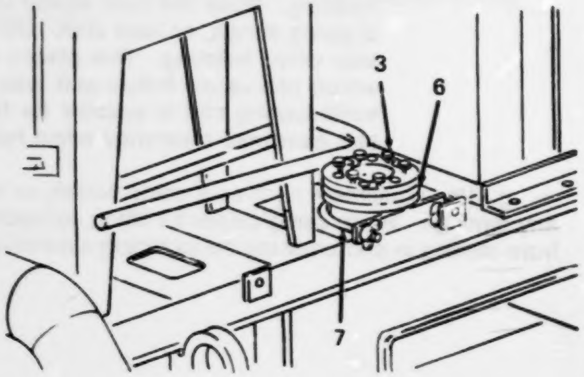
(3) Remove power pack (4) with rubber hammer.



(4) Install bolts (3) into power pack (6) and fasten to skid with U-bolt (7).

(5) Assemble the end operating as a butt strap on the sound proofing booth.

(6) Protect flanges of hubs (4 and 5) and coupling (6) during shipment by lubricating and covering with protective cloth and tape.



2-61. PREPARATION FOR SHIPMENT (CONT)

d. Ensure battery and tool boxes are securely closed and tool boxes locked.

e. Verify that grounding rods, muffler, intake duct, muffler guard, and suction and discharge nozzle adapters are stowed at their clamped and proper position on the skid assembly.

CAUTION

Upon completion of these procedures, attach a red tag in the vicinity of the starting device with the following information:

Deprocess this engine in accordance with instructions contained on DA Form 2258 or DD Form 1397 (attached to this equipment). Failure to do so could cause damage to equipment. In addition, the air cleaners, fill caps, exhaust stacks, tail pipes, breather tubes, dipstick tubes, fuel cap vent holes, battery filler openings, and accessories have been sealed. Remove all seals prior to cranking the engine.

f. Package unit as follows:

NOTE

For long term outside storage or shipment of the pumping assembly, a plywood packing container should be fabricated or the original container utilized.

(1) Fabricate a plywood packing container if original container cannot be used.

(2) Position container on pumping assembly and fasten securely.

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

g. Use equipment such as a crane, forklift, or other cargo-lifting equipment to load the pump unit without any damage. When using cables for lifting, spreader bars of adequate length must be used to prevent cables from closing in and crushing the pumping assembly.

CHAPTER 3
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

INTRODUCTION

This chapter contains the following frequently used maintenance information:

a. Troubleshooting

b. Maintenance procedures

The symptom index on page 3-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 3-6.

Section	Title	Page
I	Troubleshooting	3-1
II	Maintenance Procedures	3-6

Section I. TROUBLESHOOTING

3-1. TROUBLESHOOTING

a. Table 3-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of direct support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections or corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of direct support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to TM 5-4320-307-10. For troubleshooting procedures within the scope of unit maintenance, refer to table 2-2.

3-2. SYMPTOM INDEX

Refer to the symptom index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the pumping assembly. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks at low speed	3-3
2	Engine starts but runs unevenly, stalls, or surges	3-3
3	Engine stops running or produces black, white, or grey smoke	3-4
4	Engine consumes excessive lube oil	3-4
5	Engine oil pressure is low	3-5
6	Pump does not discharge or has low discharge pressure	3-5
7	Pump makes excessive noise	3-5

Table 3-1. Direct Support Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

---

1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

Step 1. Check for faulty starter motor.

Test and repair faulty starter motor (para 3-22).

Step 2. Check for restricted impeller.

Remove pump body (para 3-8) and remove foreign objects restricting impeller.

2. ENGINE STARTS BUT RUNS UNEVENLY, STALLS, OR SURGES

Step 1. Check adjustment of fuel pump.

Adjust fuel pump (para 3-29).

Step 2. Check for air in the fuel system.

Service fuel pump (para 3-29).

Step 3. Check for malfunctioning fuel pump.

Replace fuel pump (para 3-29).

Step 4. Check for faulty injectors. Remove and test injectors.

Repair or replace faulty injectors (para 3-35).

Step 5. Check governor control.

Replace faulty governor (para 3-13).

Step 6. Check overspeed switch.

Replace faulty overspeed switch (para 3-14).

Step 7. Check HVT valve assembly.

Replace faulty HVT valve assembly (para 3-27).

Table 3-1. Direct Support Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

---

3. ENGINE STOPS RUNNING OR PRODUCES BLACK, WHITE, OR GREY SMOKE

Step 1. Check adjustment of fuel pump.

Adjust fuel pump (para 3-29).

Step 2. Check for faulty injectors. Remove and test injectors.

Repair or replace faulty injectors (para 3-35).

Step 3. Check for malfunctioning fuel pump.

Replace fuel pump (para 3-29).

Step 4. Check for air in the fuel system.

Service fuel pump (para 3-29).

4. ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)

Step 1. Check for leaking oil pan.

If oil pan is leaking, remove from crankcase, replace gasket and install (para 3-38).

If oil pan continues to leak, replace it (para 3-38).

Step 2. Check for lube oil cooler leaks. Clean lube oil cooler and check for leaks.

If lube oil cooler leaks, remove and install with new gasket. If leakage continues, replace lube oil cooler (para 3-32).

Step 3. Check for leaking head gasket:

a. Inspect engine oil for evidence of engine coolant.

b. Inspect engine coolant for evidence of engine oil. Replace cylinder head or gasket as required (para 3-36).

Table 3-1. Direct Support Troubleshooting (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

---

5. ENGINE OIL PRESSURE IS LOW

Step 1. Check for clogged lube oil cooler. Inspect lube oil cooler.

Replace a clogged or otherwise faulty lube oil cooler (para 3-32).

Step 2. Check for partially clogged oil suction pipe.

Replace an oil suction pipe that is damaged or cannot be cleaned adequately (para 3-38).

Step 3. Check for air leak in oil suction pipe. Inspect oil suction pipe.

Replace a faulty oil suction pipe (para 3-38).

Step 4. Check for worn or damaged lube oil pump. Inspect lube oil pump.

Repair or replace a faulty lube oil pump (para 3-31).

6. PUMP DOES NOT DISCHARGE OR HAS LOW DISCHARGE PRESSURE

Step 1. Check for malfunctioning pressure regulator.

Replace faulty pressure regulator (para 3-15).

Step 2. Check for broken impeller. Disassemble pump (para 3-8). Inspect impeller.

Replace impeller if necessary (para 3-8).

7. PUMP MAKES EXCESSIVE NOISE

Step 1. Check flexible coupling.

Tighten, adjust, or replace as necessary (para 3-7).

Step 2. Check for foreign matter in pump. Disassemble pump (para 3-8). Inspect for foreign matter.

Remove foreign matter.

Step 3. Check bearing assembly. Disassemble pump (para 3-8).

Replace bearing if necessary (para 3-8).

Section II. MAINTENANCE PROCEDURES

INDEX

Para

Accessory Drive Assembly Repair/Replace 3-30
Aftercooler Repair 3-24
Alternator Repair 3-21
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Cam Follower Inspect/Repair/Replace 3-34
Casing and Cover Replace 3-10
Cylinder Head Assembly Inspect/Replace 3-36
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Fan Hub and Bracket Repair 3-25
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Fuel Pump Assembly Service/Test/Replace 3-29
Fuel Tubing Repair/Replace 3-28
Gear Cover Assembly Inspect/Repair 3-39
Governor Control Inspect/Test/Replace 3-13
HVT Valve Assembly Test/Repair/Replace 3-27
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Lube Oil Cooler Assembly Inspect/Test/Repair 3-32
Lubricating Oil Pump Assembly Inspect/Replace 3-31
Mechanical Seal and Bearing Assembly Repair/Replace 3-11
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Piping and Vent Assembly Repair 3-9
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Pump Assembly Repair/Replace 3-8
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Radiator Assembly Repair 3-19
Rocker Lever Housing Assembly Repair/Replace 3-33
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Tank Assembly Repair 3-4
Water Pump Assembly Repair 3-26
Water Manifold Repair/Replace 3-23

3-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following.

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and START/STOP switch set at STOP. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix D to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in the procedure. Standard torque values given in Appendix D are determined by thread size.
- If fuel tank has broken welds, dry it thoroughly before reworking cracked welds.

3-4. TANK ASSEMBLY REPAIR

This task covers: Cleaning/Inspection/Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Explosive vapor detector (Item 2, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Soap (Item 20, Appendix C)

Paint (Item 23, Appendix C)

Emery cloth (Item 2, Appendix C)

Wire brush

Manual References

TM 9-237

Equipment Condition Reference	Condition Description
Paragraph 2-22	Tank assembly removed

General Safety Instructions

Well ventilated area required for cleaning, welding, and painting procedures.

CLEANING/INSPECTION/REPAIR:

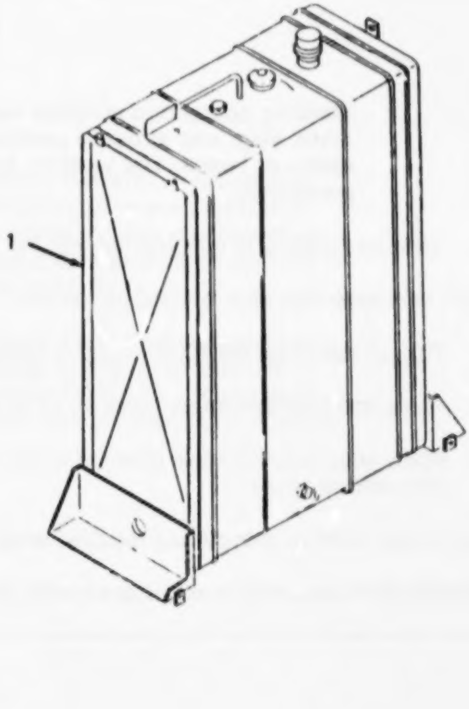
1 Inspect tank assembly (1) for fuel seepage or wet spots. Mark areas for repair.

2 Inspect tank assembly (1) for the following:

a. Dents and gouges.

b. Cracks or punctures which require welding.

c. Rust or corrosion that could become a source of future leaks. Test these areas by tapping with a sharp center punch. If area is easily penetrated, replace fuel tank.



3-4. TANK ASSEMBLY REPAIR (CONT)

3 Weld small gouges, cracks, or punctures in tank or cracks at fitting or tank welds as follows:

WARNING

Although not as flammable as gasoline, diesel fuel is volatile and the vapor will burn or explode. To avoid injury to personnel, do not weld fuel tank, or perform other operations that may produce sparks, until fuel tank is rendered safe.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

NOTE

Do not weld patches on tank. If damage is not repairable without patch, replace the tank.

a. Steam clean inside of fuel tank for at least four hours. During this time, high pressure steam should be introduced alternately into all openings to vaporize and flush away all residual fuel.

b. At end of steaming period, check for residual fuel vapors using explosive vapor detector. If explosive vapors are detected, repeat steam cleaning.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding mask with properly tinted lens, apron or jacket, and welders boots are required to avoid injury to personnel.

c. Weld as required in accordance with TM 9-237.

4 Test tank assembly after welding as follows:

a. Plug all openings except filler cap opening.

b. Apply and maintain an air pressure of 3 psi (21 kPa) to tank assembly through filler cap opening.

c. Apply soap solution to all repaired areas and suspected leak areas and check for bubbles. Bleed off air and remove plugs.

5 Use emery cloth to smooth out repaired areas and repaint.

6 Replace tank assembly in accordance with paragraph 2-22.

3-5. ENGINE ENCLOSURE REPAIR

This task covers: Cleaning/Inspection/Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Grinder

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Paint (Item 23, Appendix C)

Emery cloth (Item 2, Appendix C)

Wire brush

Eye protection

Respiratory protection

Personnel Required

Two

Manual References

TM 9-237

Equipment Condition Reference	Condition Description
Paragraph 2-23	Engine enclosure removed

General Safety Instructions

Well ventilated area required for cleaning, welding, and painting procedures.

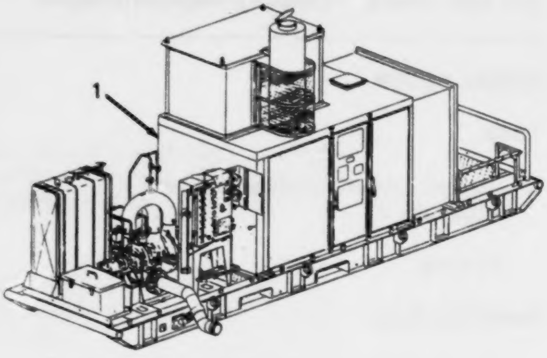
CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

3-5. ENGINE ENCLOSURE REPAIR (CONT)



1 Clean engine enclosure (1) with wire brush and rag moistened with dry cleaning solvent to remove all traces of grease and oil. Dry with compressed air.

2 Inspect engine enclosure (1) for rust spots, dents, cracks, and gouges.

3 Inspect all mounting holes for distortion and tearing.

4 Inspect all latches and handles for proper operation.

5 Check frame for cracked welds.

6 Straighten out dents as necessary.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, properly tinted lenses, an apron or jacket, and welders' boots are required to avoid injury to personnel.

7 Weld cracks, punctures, or tears in sheet metal, using patches on areas which are rusted through. Repair any cracked welds in frame. Refer to TM 9-237.

WARNING

Grinding operations create airborne abrasive dust and particles. Respiratory and eye protection is required to avoid injury to personnel.

8 Grind smooth any gouges.

9 Use emery cloth to smooth out repaired areas and repaint.

10 Replace engine enclosure in accordance with paragraph 2-23.

3-6. STORAGE BOX AND COVER REPAIR

This task covers: Cleaning/Inspection/Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Grinder

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Paint (Item 23, Appendix C)

Emery cloth (Item 2, Appendix C)

Wire brush

Eye protection

Respiratory protection

Manual References

TM 9-237

Equipment Condition Reference	Condition Description
Paragraph 2-24	Storage box and cover removed

General Safety Instructions

Well ventilated area required for cleaning, welding, and painting procedures.

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

3-6. STORAGE BOX AND COVER REPAIR (CONT)

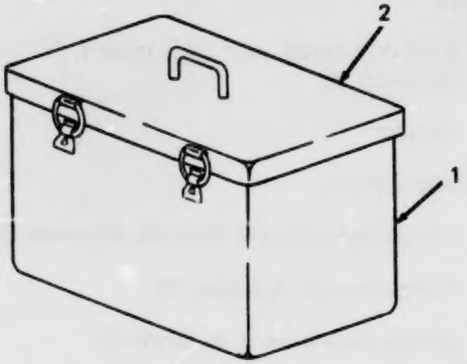
1 Clean storage box (1) and cover (2) with wire brush and dry cleaning solvent to remove all traces of grease and oil. Dry with compressed air.

2 Inspect storage box and cover for rust spots, dents, cracks, punctures, and gouges.

3 Inspect mounting holes for distortion and tearing.

4 Inspect storage box for cracked welds.

5 Straighten out dents in storage box and cover as necessary.



WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, properly tinted lenses, an apron or jacket, and welders' boots are required to avoid injury to personnel.

6 Weld cracks, punctures, or tears in sheet metal, using patches on rusted areas if necessary. Refer to TM 9-237.

WARNING

Grinding operations create airborne abrasive dust and particles. Respiratory and eye protection is required to avoid injury to personnel.

7 Grind smooth any gouges.

8 Use emery cloth to smooth out repaired areas and repaint.

9 Replace storage box and cover in accordance with paragraph 2-24.

3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation d. Alignment

INITIAL SETUP

Test Equipment

Inside micrometer (Item 3, Appendix B)

Magnetic base dial/indicator set (Item 5, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Tools

Torque wrench (Item 2, Appendix B)

Rubber hammer

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area

REMOVAL:

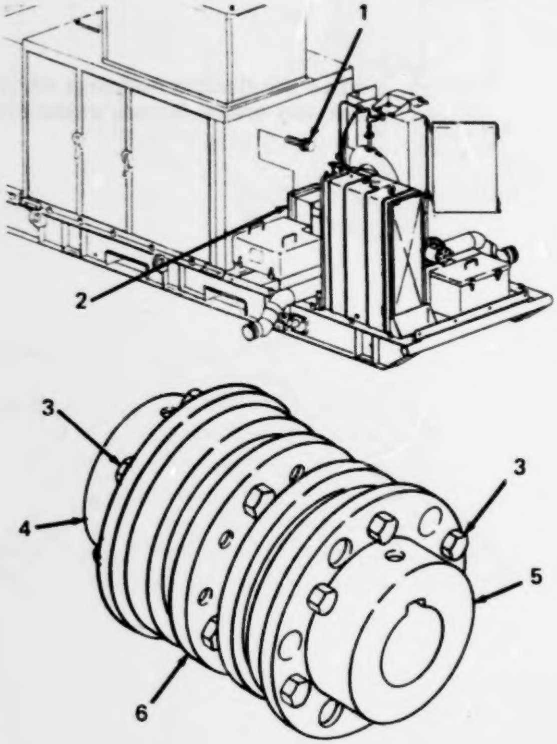
1 Remove four bolts and washers (1) securing protective cover (2) to engine enclosure and remove cover.

2 Remove bolts (3) from standard hub (4) and hub (5).

CAUTION

Do not pry apart hub grooves as this may damage the machined surfaces.

3 Remove flexible coupling (6) with rubber hammer.



3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean flexible coupling and dry with compressed air.

2 Inspect membranes, bolts, bushings, and exterior surfaces of hubs for damage and excessive wear.

3 Repair is limited to the replacement of faulty part.

NOTE

When the flexible coupling requires replacement, it must be replaced as a unit and only a factory assembled and balanced unit should be used.

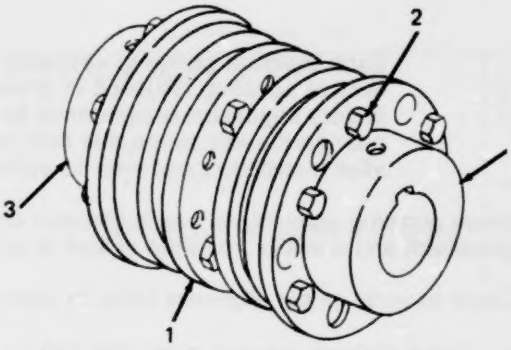
3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

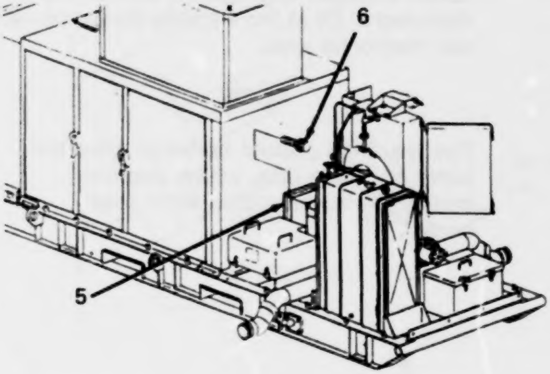
INSTALLATION:

1 Install flexible coupling (1).

2 Install bolts (2) in standard hub (3) and hub (4).

3 Position protective cover (5) on engine enclosure and secure using four bolts and washers (6).





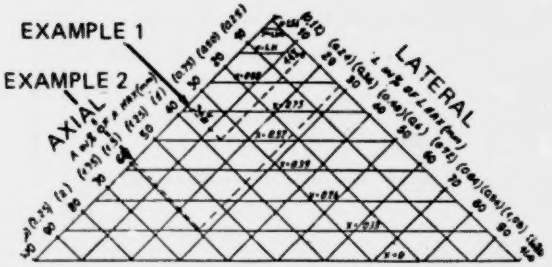
ALIGNMENT:

NOTE

Individual maximum alignment tolerances allowed are:

Axial - 2.5 mm (about 0.10 inch)
Radial - 1.2 mm (about 0.05 inch)
Angular - 0.5 degrees (30 min.)

Angular tolerance is difficult to measure accurately. The average long term tolerance deviations to provide extended coupling life are approximately 10 percent of the maximum individual allowances listed above. All three tolerances listed are interrelated upon adjustment. An acceptable conservative relationship that can be field applied is shown by the coordinate graph.



3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

NOTE

Each mainline pumping assembly is factory aligned and shipped with the flexible coupling removed to prevent potential shipping damage. Normal factory alignment is performed to very stringent requirements in order to provide the assurance that field realignment requirements are minimized after installation and prior to operation.

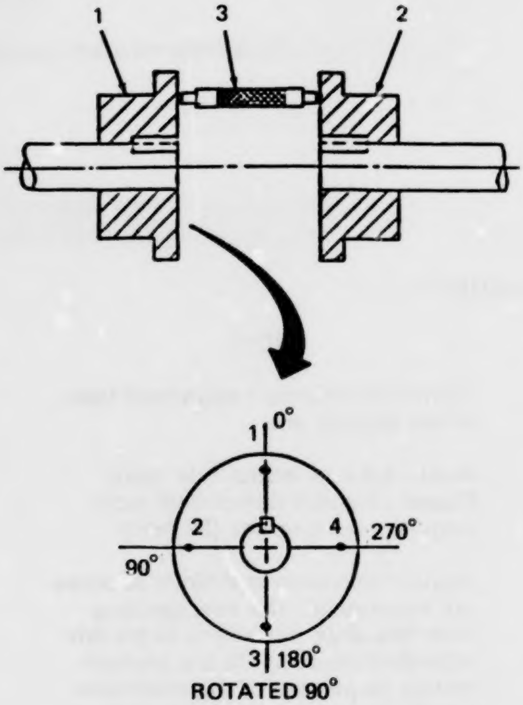
1 Insure pumping assembly is installed/located on a flat prepared surface (concrete, wooden platform, or gravelbed) and is within 5 degrees of level in any direction. Refer to TM 5-4320-307-10.

2 Check to verify proper alignment between pump and speed increaser gear half couplings as follows:

a. Check distance between pump side hub (1) and speed increaser side hub (2) with an inside micrometer (3) at the 4 points shown on vertical and horizontal axes.

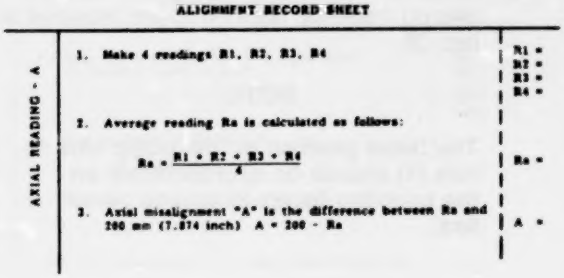
NOTE

The readings should be taken near the outer coupling ring, all on approximately the same radius from shaft center.



3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

b. Record these axial readings (R1 through R4) on Alignment Record Sheet. The difference between nominal (200 mm) coupling dimension and average axial reading Ra is then A, the axial misalignment error.

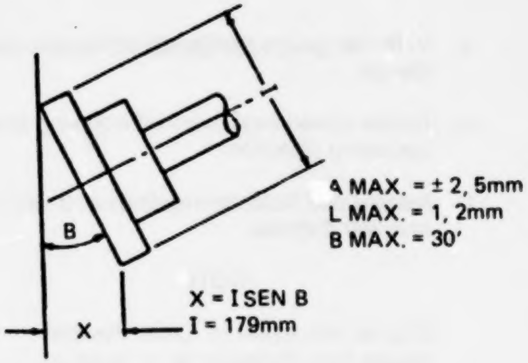


ALIGNMENT RECORD SHEET

AXIAL READING - A	1. Make 4 readings R1, R2, R3, R4	R1 = R2 = R3 = R4 =
	2. Average reading Ra is calculated as follows: $Ra = \frac{R1 + R2 + R3 + R4}{4}$	Ra =
	3. Axial misalignment "A" is the difference between Ra and 200 mm (7.874 inch) A = 200 - Ra	A =

NOTE

The maximum difference between opposite readings taken above (R1-R3 or R2-R4) corresponds tc the X value and represents the angular misalignment.

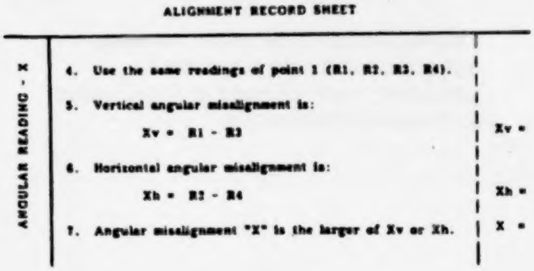


A MAX. = ± 2, 5mm
L MAX. = 1, 2mm
B MAX. = 30′

X = I SEN B
I = 179mm

NOTE

See calculation method in Alignment Record Sheet, Angular Reading.



ALIGNMENT RECORD SHEET

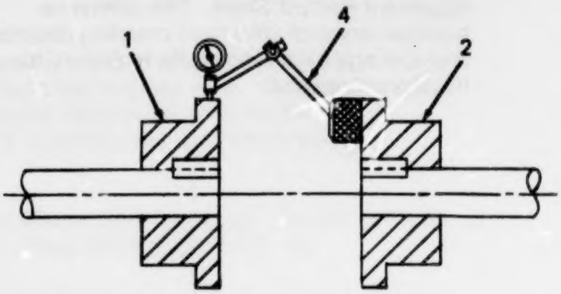
ANGULAR READING - X	4. Use the same readings of point 1 (R1, R2, R3, R4).	
	5. Vertical angular misalignment is: Xv = R1 - R3	Xv =
	6. Horizontal angular misalignment is: Xh = R2 - R4	Xh =
	7. Angular misalignment "X" is the larger of Xv or Xh.	X =

3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

c. Install dial indicator and magnetic base (4) placing magnetic base on speed increaser side hub (2).

NOTE

The feeler position on the pump side hub (1) should be approximately on the coupling flange thickness center line.



d. With dial gauge positioned at the top, zero the gauge.

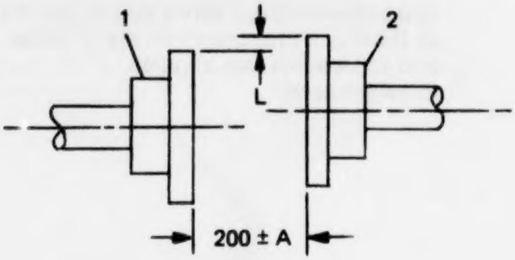
e. Rotate speed increaser half coupling slowly in operating direction.

f. Record dial indicator readings at 0, 90, 180, 270, and 360 degrees.

NOTE

If L0 is not equal to L360, the dial gauge has moved or is in need of calibration. Replace if necessary and take another set of readings.

The maximum difference between opposite headings (L0-L180 or L90-L270) corresponds to the L value or lateral misalignment.

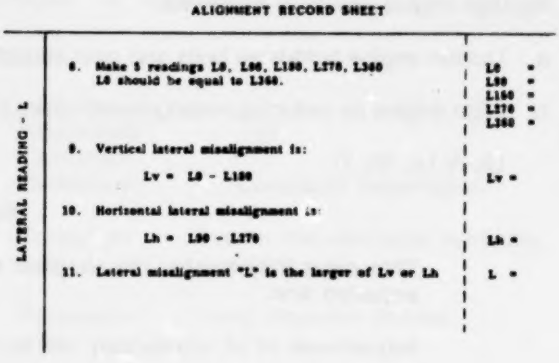


A MAX. = ± 2, 5mm
L MAX. = ± 1, 2mm
B MAX. = 30′

3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

NOTE

See calculation method on Alignment Record Sheet Lateral Reading.



ALIGNMENT RECORD SHEET

LATERAL READING - L

8. Make 5 readings L0, L90, L180, L270, L360
L0 should be equal to L360.

L0 =
L90 =
L180 =
L270 =
L360 =

9. Vertical lateral misalignment is:

Lv = L0 - L180

Lv =

10. Horizontal lateral misalignment is:

Lh = L90 - L270

Lh =

11. Lateral misalignment "L" is the larger of Lv or Lh

L =

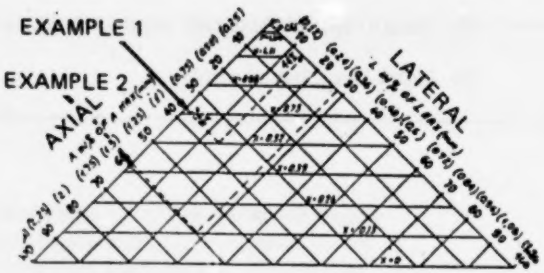
g. Check that readings do not exceed maximum coupling manufacturers tolerances.

Amax = ± 2.5 mm (0.098 inch)
Xmax = 1.56 mm (0.061 inch)
Lmax = 1.2 mm (0.047 inch)

NOTE

Example 1 is an entry of A = 0.035 inch (36% of 0.098), L = 0.007 inch (14% of 0.047) and X = 0.020 inch (0.52 mm). Any point on the graph indicates an acceptable field alignment check. The smaller angular error (X = 0.13 mm or 0.005 inch) in Example 2 allows a greater misalignment in both A (1.48 mm or 0.058 inch) and L (0.34 mm or 0.013 inch). Both Examples 1 and 2 indicate acceptable conditions not requiring engine realignment. Smaller X, L, or A than any point read from the graph is also acceptable.

If the correlated misalignment values do not fall within the limits indicated, realignment of the engine is required. Proceed to step 3.



3-7. FLEXIBLE COUPLING INSPECT/ALIGN/REPAIR/REPLACE (CONT)

3 Re-align engine assembly as follows:

a. Loosen engine holddown bolts and gear support L-bracket bolts to skid.

b. Align engine by reducing misalignment values in the following order.

Lh, A, Lv, Xh, Xr

NOTE

This order insures that the simplest and most sensitive parameters are adjusted first.

Adjustment of all values may not be necessary.

(1) To reduce Lh, use lateral jacking screws (equally from one side or the other) to push engine sideways.

(2) To reduce A, use jacking screws to move engine toward or away from pump.

(3) To reduce Lv, add or remove an equal thickness of shims to/from all four (front and rear) engine pads.

(4) Check the misalignment values by repeating step (b).

(5) Torque engine mounting bolts to 123 ft-lbs (167 N•m).

(6) Torque speed increaser support bolts to 50 ft-lbs (68 N•m).

(7) Install coupling assembly.

3-8. PUMP ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Suitable lifting device

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Suitable blocks

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-56	Suction and discharge assembly removed
Paragraph 2-25	Pump assembly drained
Paragraph 3-7	Flexible coupling removed
Paragraph 3-9	Piping and vent assembly removed

General Safety Instructions

Well ventilated area

Insure proper lifting methods and procedures

REMOVAL:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

3-8. PUMP ASSEMBLY REPAIR/REPLACE (CONT)

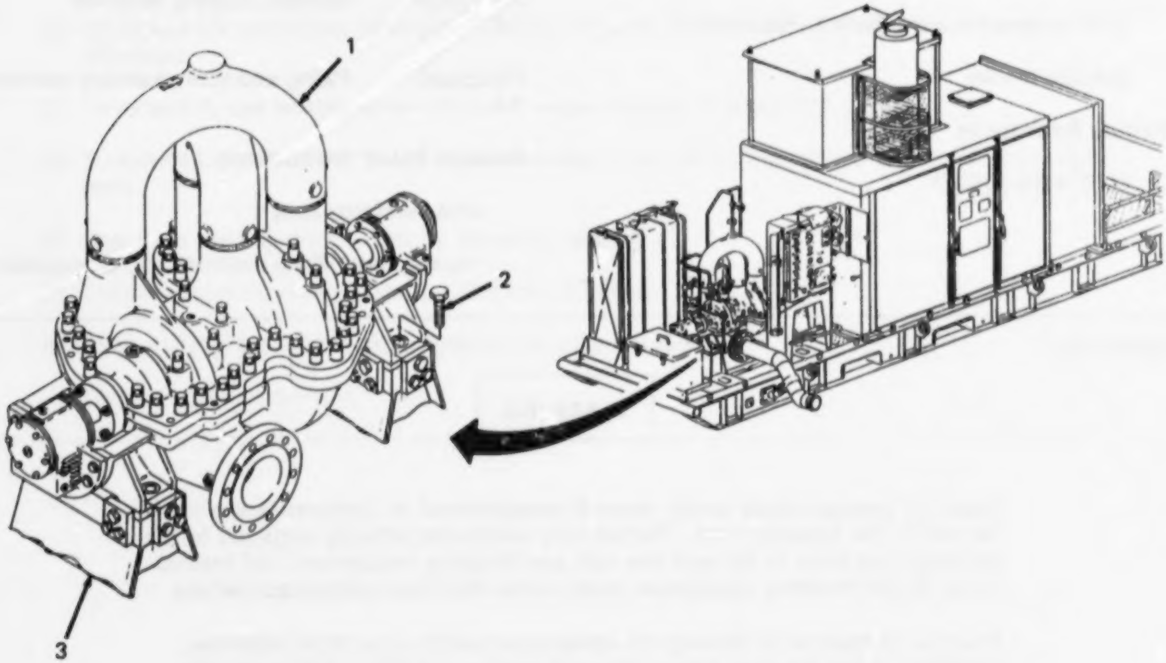
WARNING

Because this part weighs more than 2250 lbs (1020 kg), a hoist will be required to lift the pump to avoid personal injury.

1 Position a suitable lifting device and slings over pump assembly (1). Attach slings around assembly and put tension on slings. Make sure pump assembly is properly supported.

2 Remove four bolts (2) securing pump (1) to skid (3).

3 Lift pump straight up from skid and lower onto blocks on a stable level work platform.



CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean pump assembly and dry with compressed air.

2 Inspect pump assembly for cracks, rust, corrosion, or other damage.

3 Inspect mounting surfaces and insure they are smooth and flat with no nicks or burrs.

4 Repair minor nicks or burrs on pump body or bearing housing and smooth out mounting surfaces with crocus abrasive cloth. Clean and refinish outside surfaces. Remove only a minimal amount of surface material.

NOTE

For repair or replacement of major pump assembly components refer to the following paragraphs:

Mechanical Seal and Bearing Assembly (para 3-11)

Casing and Cover Assembly (para 3-10)

Shaft Assembly Inspection (para 3-12)

3-8. PUMP ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Position a suitable lifting device and slings over pump assembly (1). Attach slings around assembly and put tension on slings. Make sure pump assembly is properly supported.

2 Lift and remove pump assembly (1) from blocks on work platform.

3 Lower pump assembly (1) carefully so that it aligns with mounting holes on skid (2). Remove lifting device.

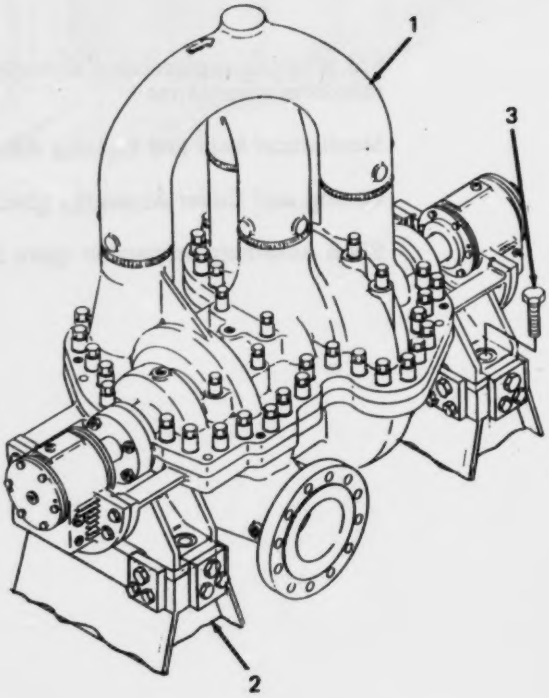
4 Install four bolts (3) and torque to 369 ft-lb (500 N-m) and secure pump to skid (2).

5 Install piping and vent assembly in accordance with paragraph 3-9.

6 Install flexible coupling in accordance with paragraph 3-7.

7 Fill pump assembly in accordance with paragraph 2-25.

8 Install suction and discharge assembly in accordance with paragraph 2-56.



3-9. PIPING AND VENT ASSEMBLY REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Packing

Gaskets

Seals

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
TM 5-4320-307-10	Pumping assembly off and in a safe condition

General Safety Instructions

Well ventilated area

DISASSEMBLY:

WARNING

Insure all pressure is bled from pumping assembly. Failure to do so could result in death or injury.

NOTE

It is not necessary to remove the piping and vent assemblies in order to disassemble and repair the vent valves.

3-9. PIPING AND VENT ASSEMBLY REPAIR (CONT)

1 Remove air vent valve handwheel nut (1) and washer (2).

2 Remove handwheel (3).

3 Remove yoke nut locker (4).

4 Remove yoke nut (5).

5 Remove gland nuts (6).

6 Remove gland flange (7).

7 Remove packing gland (8).

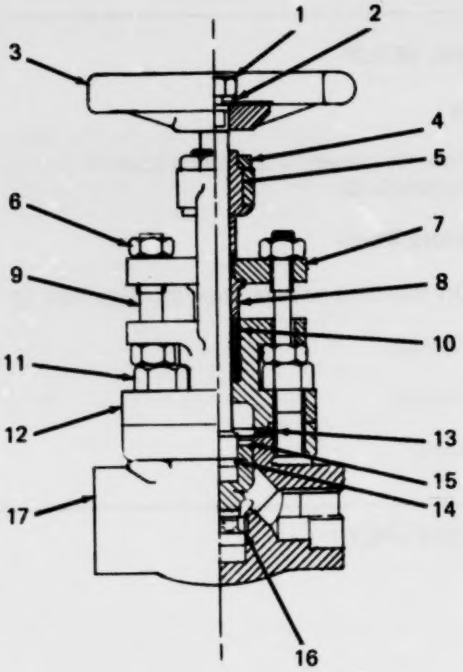
8 Remove gland bolt studs (9).

9 Remove packing (10).

10 Remove four bolts and lockwashers (11), bonnet (12), and gasket (13).

11 Remove stem disc connecting ring (14) and disc (15).

12 Remove seat (16) from body (17).



CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

3-9. PIPING AND VENT ASSEMBLY REPAIR (CONT)

1 Clean air vent valve metal components with dry cleaning solvent and dry with compressed air.

2 Inspect air vent valve metal components for cracks, rust, corrosion, or other damage.

3 Repair air vent valve by replacing packings, gaskets, and seats.

ASSEMBLY:

1 Install seat (1) into body (2).

2 Install disc (3) and stem disc connecting ring (4).

3 Install gasket (5), bonnet (6) and fasten with four bolts and lockwashers (7).

4 Install new packing (8).

5 Install gland bolt studs (9).

6 Install new packing gland (10).

7 Install gland flange (11).

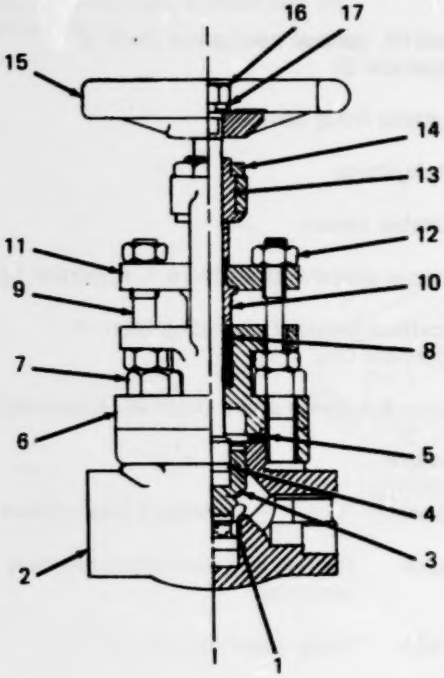
8 Install gland nut (12).

9 Install yoke nut (13).

10 Install yoke nut locker (14).

11 Install handwheel (15).

12 Install handwheel nut (16) and washer (17).



3-10. CASING AND COVER REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable lifting device

Materials/Parts

Suitable blocks

Crocus abrasive cloth (Item 1, Appendix C)

Moldable polymer gasketing (Item 21, Appendix C)

Spray solidifying agent (Item 29, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-56	Suction and discharge assembly removed
Paragraph 2-25	Pump assembly drained
Paragraph 3-7	Flexible coupling removed
Paragraph 2-26	Piping and vent assembly removed
Paragraph 3-8	Pump assembly removed
Paragraph 3-11	Mechanical seal and bearing assembly removed

General Safety Instructions

Well ventilated area

Insure proper lifting methods and procedures

REMOVAL:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

3-10. CASING AND COVER REPLACE (CONT)

1 Remove the pump cover as follows:

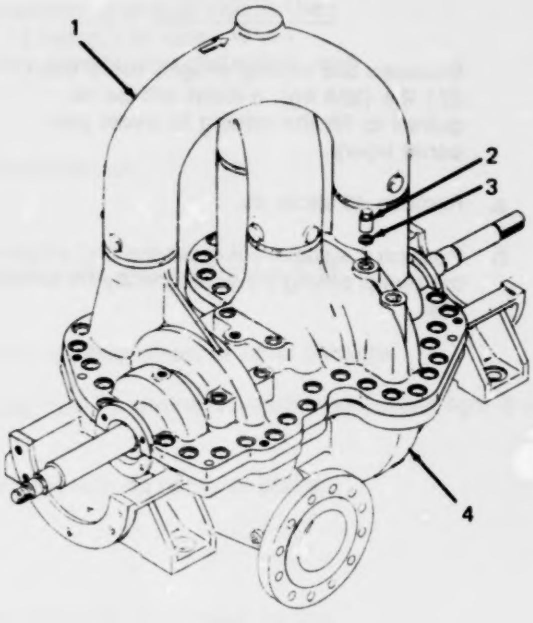
WARNING

Because the pump cover weighs more than 551 lbs (250 kg), a hoist will be required to lift the shaft in order to avoid personal injury.

a. Position a suitable lifting device and slings over pump cover (1).

b. Remove 46 cap nuts (2) and washers (3).

c. Lift pump cover (1) from pump casing (4) and carefully place into blocks on a stable work platform.



2 Remove shaft assembly as follows:

WARNING

Because the pump shaft weighs more than 260 lbs (118 kg), a hoist will be required to lift the shaft in order to avoid personal injury.

3-10. CASING AND COVER REPLACE (CONT)

a. Position a suitable lifting device and slings over shaft assembly (5).

b. Lift shaft assembly (5) from pump casing (4) and carefully place onto blocks on a stable work platform.

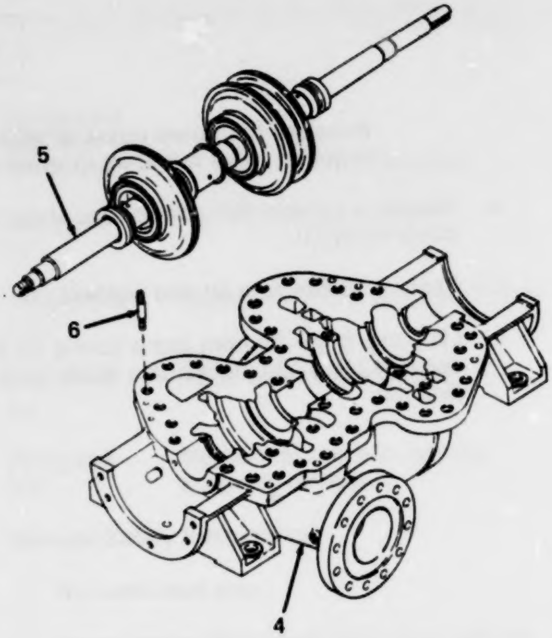
3 Remove pump casing as follows:

WARNING

Because the casing weighs more than 871 lbs (395 kg), a hoist will be required to lift the casing to avoid personal injury.

a. Remove 46 studs (6).

b. Position a suitable lifting device and slings over the pump casing (4) and carefully lift to desired area.



3-10. CASING AND COVER REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean cover and casing assembly and dry with compressed air.

NOTE

Inspect the pump shaft assembly in accordance with paragraph 3-12.

2 Inspect cover and casing for cracks, rust, corrosion, eroded or pitted areas, or other damage.

3 Inspect wearing ring grooves in cover and casing for pitting, cuts, or distortion which could affect tight fit of wearing rings.

4 Inspect mounting surfaces and insure they are smooth and flat with no necks or burns.

NOTE

If repair requires replacement of the casing or cover, they must be procured as a matched set.

5 Repair minor nicks or burrs on cover and casing and smooth out mounting surfaces with crocus abrasive cloth. Clean and refinish outside surfaces. Remove only a minimum amount of surface material.

3-10. CASING AND COVER REPLACE (CONT)

INSTALLATION:

1 **Install pump casing as follows:**

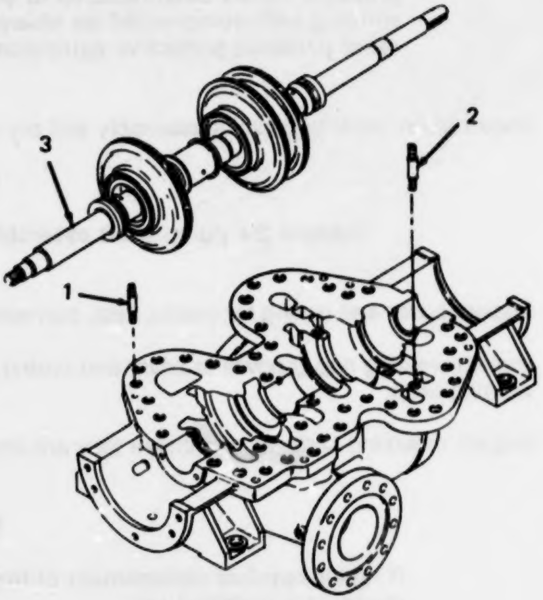
WARNING

Because the casing weighs more than 871 lbs (395 kg), a hoist will be required to lift the casing to avoid personal injury.

a. **Install 39 studs (1) and torque to 434 ft-lbs (588 N-m).**

b. **Install seven studs (2) and torque to 289 ft-lbs (392 N-m).**

2 **Install shaft assembly (3) as follows:**



WARNING

Because the pump shaft weighs more than 260 lbs (118 kg), a hoist will be required to lift the shaft in order to avoid personal injury.

a. **Position a suitable lifting device and slings over the shaft assembly.**

3-10. CASING AND COVER REPLACE (CONT)

b. Lift shaft assembly from work platform and position in pump casing (4).

c. Check the turning of the casing wear rings in casing housing. Adjust casing wear rings and seal bushing in casing housing.

3 Install pump cover as follows:

WARNING

Because the pump cover weighs more than 250 lbs (551 kg), a hoist will be required to lift the shaft in order to avoid personal injury.

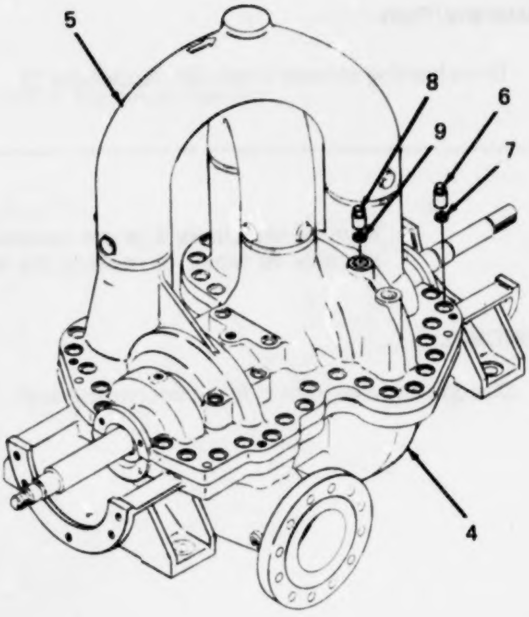
a. Position a suitable lifting device and slings over pump cover (5).

b. Evenly spread moldable polymer gasketing over pump cover and pump casing mating surfaces and spray with solidifying agent.

c. Lift pump cover (5) from work platform and place on pump casing (4).

d. Install 39 cap nuts (6) and washers (7) and torque to 434 ft-lbs (588 N•m).

e. Install seven cap nuts (8) and washers (9) and torque to 289 ft-lbs (392 N•m).



4 Install mechanical seal and bearing assembly in accordance with paragraph 3-11.

5 Install piping and vent assembly in accordance with paragraph 2-26.

6 Install flexible coupling in accordance with paragraph 3-7.

7 Refill pump assembly in accordance with paragraph 2-25.

8 Install suction and discharge assembly in accordance with paragraph 2-56.

3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection/Repair d. Assembly e. Installation

INITIAL SETUP

Tools

Parrot wrench

Pin wrench

Bearing extractor

Electric plate

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-25	Pump assembly drained
Paragraph 3-7	Flexible coupling removed
Paragraph 2-26	Piping and vent assembly removed

General Safety Instructions

Well ventilated area

NOTE

In most instances it is not necessary to remove the pump assembly from the skid to repair or replace the mechanical seals or bearing assemblies.

REMOVAL:

1 Disconnect all plumbing from mechanical seals.

3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

2 Remove shaft guard (1) by removing two screws (2).

3 Remove four nuts (3) from stud bolts (4) and loosen drive collar setscrews.

4 Remove five screws (5) connecting thrust bearing housing (6) to pump (7).

5 Remove thrust bearing cover (8) from housing (6) by removing six screws (9).

6 Remove locknut (10) and safety washer (11).

7 Remove lubricating ring (12) and lubricating bushing (13).

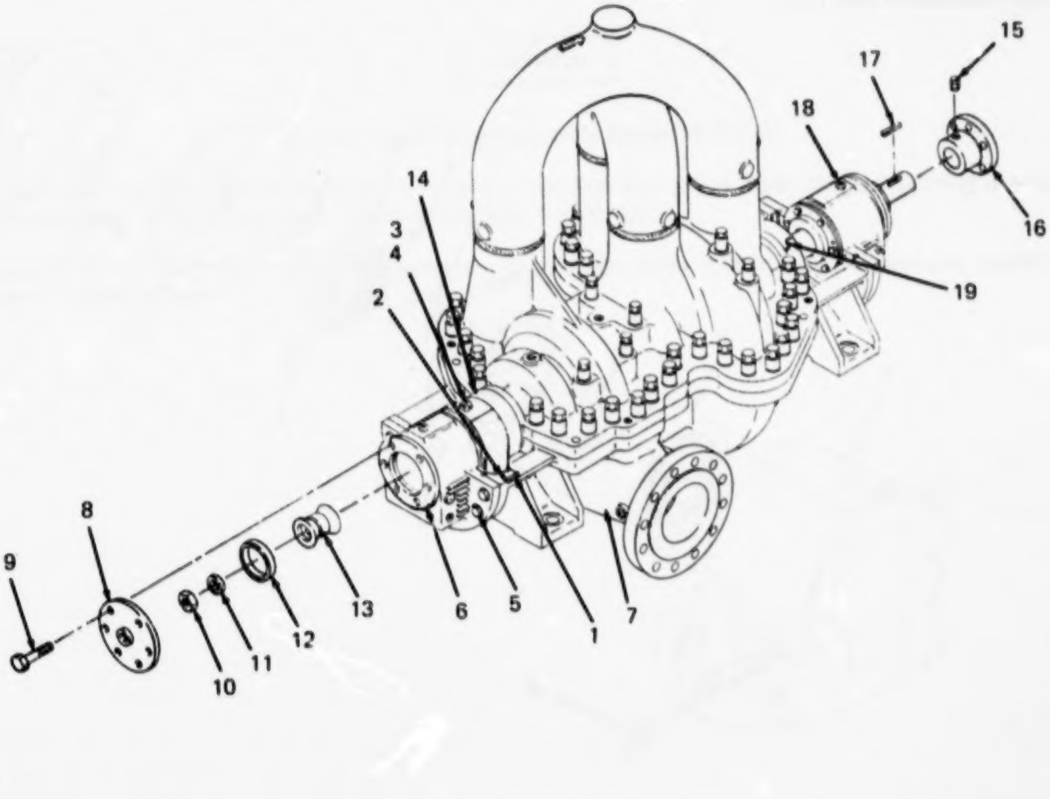
8 Remove thrust bearing housing (6) and mechanical seal (14) from pump assembly (7).

9 Remove allen setscrew (15) from coupling hub (16).

10 Remove hub (16) from pump shaft.

11 Remove key (17) from pump shaft.

12 Remove guide bearing housing (18) and mechanical seal (19) in the same manner.



3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

DISASSEMBLY:

NOTE

If further disassembly of the mechanical seals is needed, contact general support maintenance.

1 Remove labyrinth seal cover (1) from thrust bearing housing (2) by removing six screws (3).

2 Loosen grub screws (4) and remove rotating labyrinth seal (5).

3 Remove O-ring (6).

4 Remove stationary labyrinth seal (7).

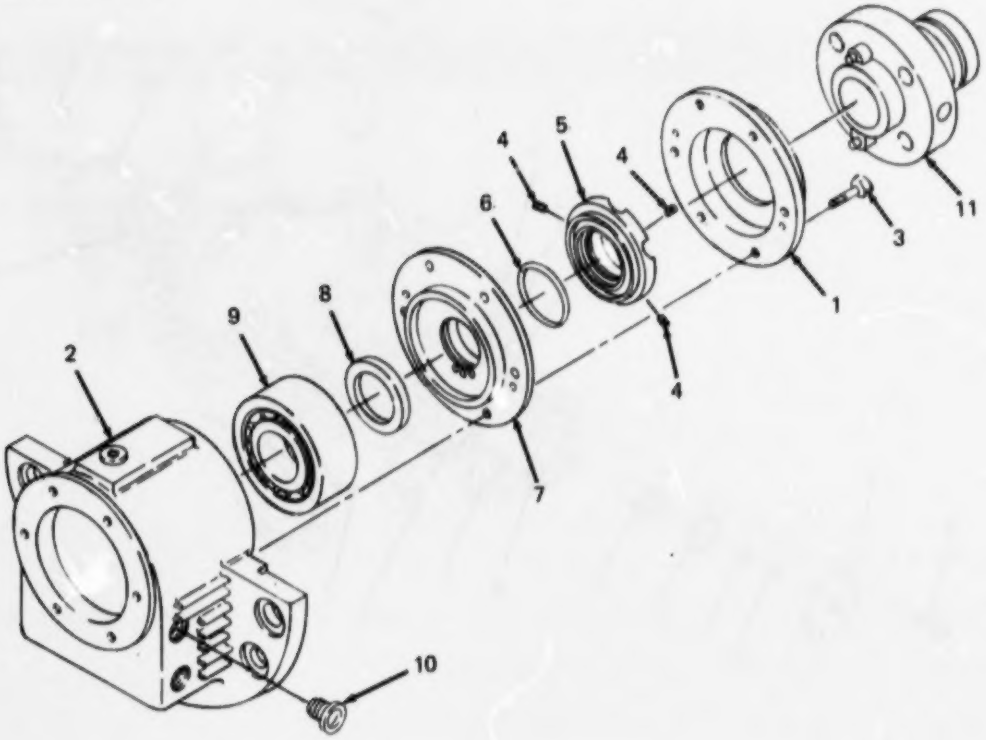
5 Remove adjustable ring (8).

6 Remove bearing (9).

7 Remove sight glass (10).

8 Disassemble guide bearing housing in the same manner.

9 Remove mechanical seal (11).



3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean bearing housing assembly metal components with dry cleaning solvent and dry with compressed air.

2 Inspect bearing housing for cracks, rust, corrosion, or other damage. Inspect for excessive wear around mounting holes and main bore. Clean interior or mounting surfaces. Clean and refinish outside surface. If housing is severely damaged, cracked, or worn, replace unit.

CAUTION

Do not rotate bearings with compressed air.

3 Inspect bearings for rough or tight spots. Replace bearings if rough or tight. Inspect bearing exterior for rust, corrosion, or other damage. Replace bearings if damaged.

4 Inspect shaft for excessive wear, rust, corrosion, or other damage. If shaft is to be replaced, contact general support maintenance.

3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

ASSEMBLY:

1 Install mechanical seal (1).

2 Install sight glass (2) into thrust bearing housing (3).

3 Install bearing (4) and adjustable ring (5). Make axial truing and final adjustment for adjustable ring (5). There should be 11 mm machining allowance.

4 Install stationary labyrinth seal (6).

5 Install O-ring (7) and rotating labyrinth seal (8). Keep 1 mm clearance between rotating labyrinth seal (8) (inside) and stationary labyrinth seal (6) (inside).

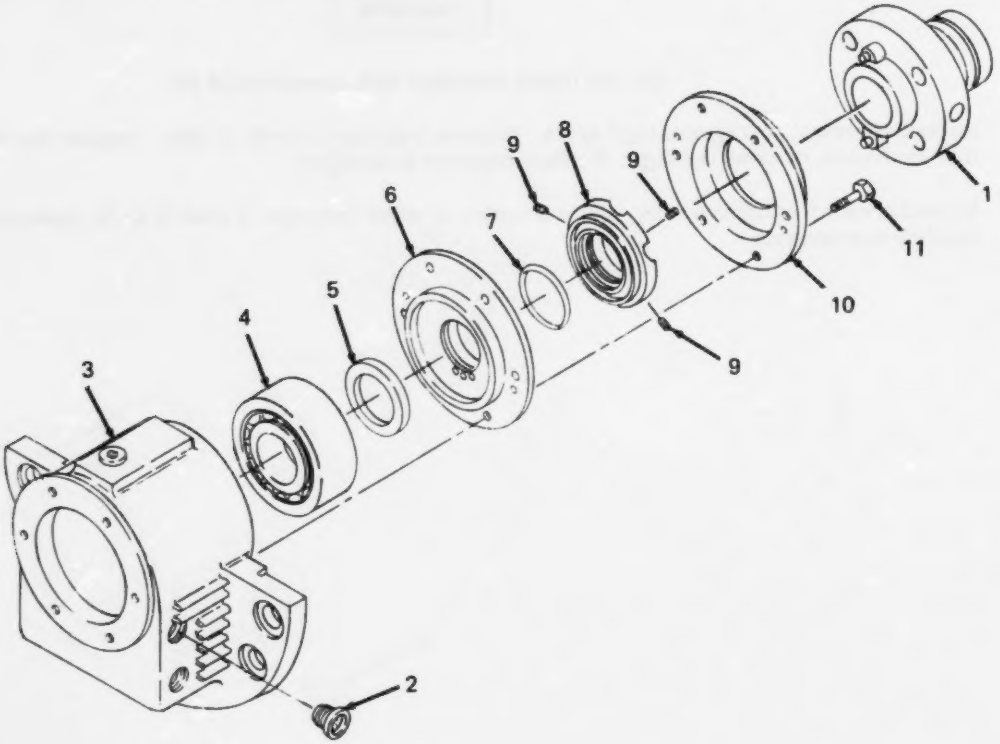
6 Install and tighten grub screws (9).

7 Install labyrinth seal cover (10) on thrust bearing housing (3) and install six screws (11). Ensure 1 mm clearance is set between cover (10) and rotating labyrinth seal (8).

NOTE

Keep the same clearances between the outside rotating and stationary labyrinth seals in the guide bearing housing.

8 Assemble guide bearing housing in the same manner.



3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:

1 Ensure that mechanical seal plate setscrews are backed off and do not protrude into bore.

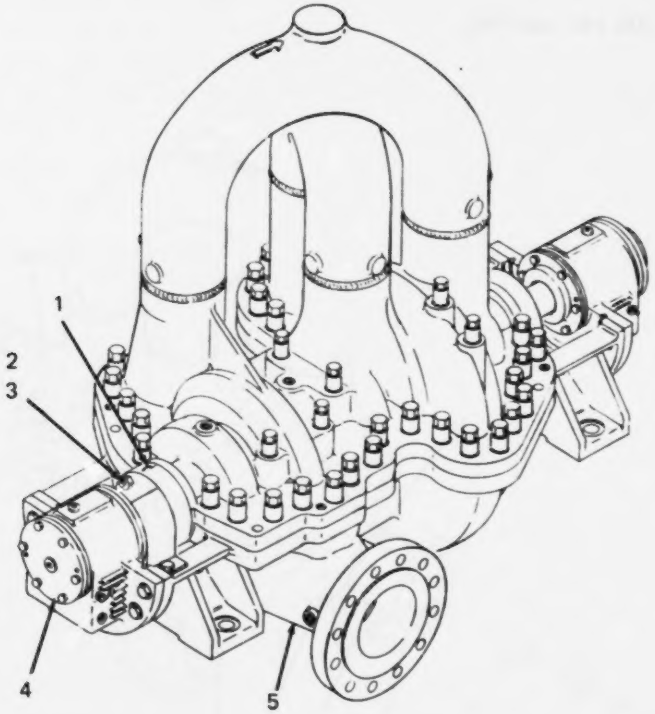
2 Install mechanical seal assembly (1) onto shaft.

3 Install seal plate nuts (2) onto studs (3) and tighten.

4 Position drive collar to shaft. Ensure that screws enter pre-drilled holes in shaft.

5 Release setting washers and lock them away from setting gap using setscrews.

6 Install thrust bearing housing (4) onto pump assembly (5).



3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

7 Install lubricating bushing (6) and lubricating ring (7).

8 Install safety washer (8) and locknut (9).

9 Position thrust bearing cover (10) onto housing (4) and secure with six screws (11).

10 Insert five screws (12) into housing (4) and secure to pump (5).

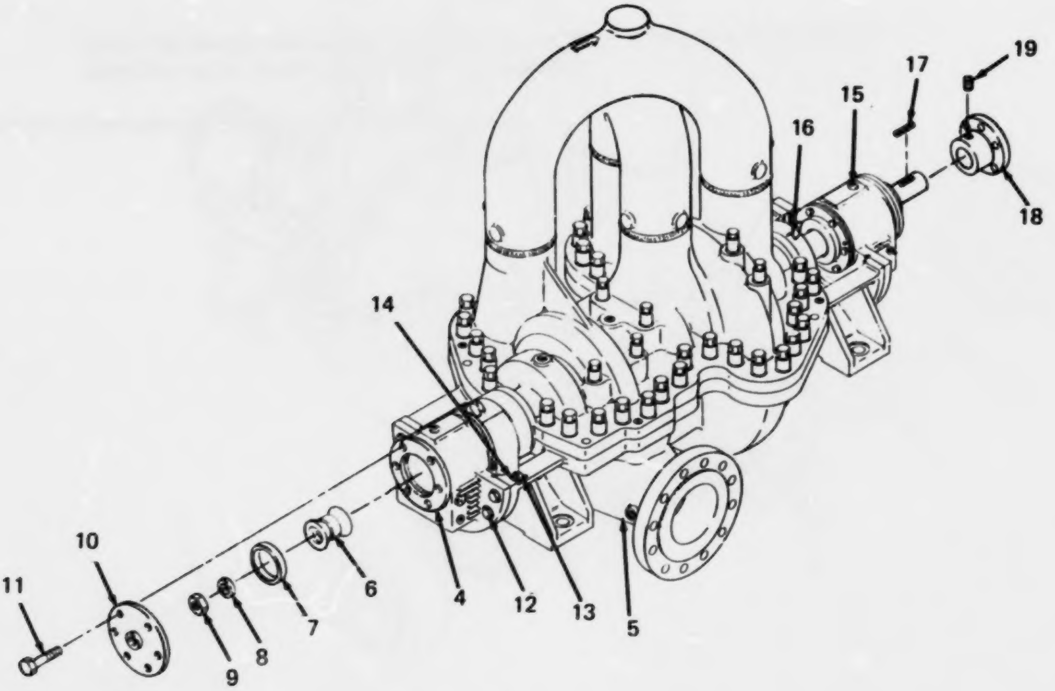
11 Position shaft guard (13) in place and secure with two screws (14).

12 Install guide bearing housing (15) and mechanical seal (16) in the same manner.

13 Install key (17) into keyway in pump shaft.

14 Install coupling hub (18) on pump shaft.

15 Install allen setscrew (19) into hub (18).



3-11. MECHANICAL SEAL AND BEARING ASSEMBLY REPAIR/REPLACE (CONT)

16 Install piping and vent assembly in accordance with paragraph 2-26.

17 Install flexible coupling in accordance with paragraph 3-7.

18 Fill pump assembly in accordance with paragraph 2-25.

3-12. PUMP, SHAFT ASSEMBLY INSPECTION

This task covers: **Inspection**

INITIAL SETUP

Equipment Condition Reference	Condition Description
Paragraph 3-10	Shaft assembly removed

General Safety Instructions

Well ventilated area

Insure proper lifting methods and procedures

INSPECTION:

Visually inspect pump shaft assembly for cracks, discoloration, and damaged parts.

NOTE

If any repair must be performed on shaft assembly, contact general support maintenance.

3-13. GOVERNOR CONTROL INSPECT/TEST/REPLACE

This task covers: a. Removal/Installation b. Inspection c. Test

INITIAL SETUP

Test Equipment	Tools
Multimeter (Item 12, Appendix B)	Tool kit, general mechanics (Item 1, Appendix B)

REMOVAL/INSTALLATION

The governor control is removed and installed in accordance with paragraph 2-29.

INSPECTION

Inspect governor control for evidence of burning or other damage.

TEST

1 Using multimeter, check supply voltage between terminals 1 and 2 of the governor control supply. Voltage should be +24 Vdc. If supply voltage is not present, check wiring.

2 With MODE CONTROL switch positioned in MANUAL, using multimeter, check voltage between terminals 8 and 9 of the governor control. Voltage shall increase from 0 to +1 Vdc as ENGINE/PUMP CONTROLLER knob is rotated from minimum to maximum. If voltage is not as stated, replace governor control.

3 Start engine in accordance with TM 5-4320-307-10 and allow engine to idle.

4 Using multimeter, check voltage between terminals 5 and 6 of the governor control. Voltage should be 11 Vac. If voltage is not 11 Vac, verify magnetic pickup on flywheel housing is mounted correctly. If magnetic pickup is mounted correctly, verify resistance between magnetic pickup terminals is approximately 300 ohms. If magnetic pickup is mounted correctly and resistance is as stated, replace governor control.

5 Stop engine in accordance with TM 5-4320-307-10. Using voltmeter, check voltage between governor control terminals 3 and 4. Voltage should be 0. Start engine in accordance with TM 5-4320-307-10 and using multimeter, verify voltage between governor control terminals 3 and 4. Voltage should be between +10 and +12 Vdc. If voltages are not as stated, replace governor control.

6 Disconnect wires from fuel pump actuator. Using multimeter, verify resistance between terminals is between 6.8 and 7.5 ohms. If resistance is as stated, replace governor control.

3-14. OVERSPEED SWITCH INSPECT/TEST/REPLACE

This task covers: a. Removal/Installation b. Inspection c. Test

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

REMOVAL/INSTALLATION

The overspeed switch is removed and installed in accordance with paragraph 2-29.

INSPECTION

Inspect overspeed switch for evidence of burning or other damage.

TEST

1 Using multimeter, check supply voltage between terminals 1 and 2 of overspeed switch. Voltage should be +24 Vdc. If supply voltage is not present, check wiring.

2 Start engine in accordance with TM 5-4320-307-10 and allow to idle. Using multimeter, check voltage between terminals 2 and 6. Voltage should be 11 Vac. If voltage is not as stated, replace overspeed switch.

3 Connect a jumper between terminals 2 and 3. Increase engine speed to 1500 RPM and verify overspeed trip. Remove jumper and verify +24 Vdc between terminals 2 and 7. If voltage is not as stated, replace overspeed switch.

4 Restart engine and using multimeter, check voltage between overspeed switch terminals 2 and 7. Voltage should be 0. If voltage is not as stated, replace overspeed switch.

3-15. PRESSURE REGULATOR INSPECT/TEST/REPLACE

This task covers: a. Removal/Installation b. Inspection c. Test

INITIAL SETUP

Test Equipment	Tools
Multimeter (Item 12, Appendix B)	Tool kit, general mechanics (Item 1, Appendix B)

REMOVAL/INSTRUCTION

The pressure regulator is removed and installed in accordance with paragraph 2-29.

INSPECTION

Inspect pressure regulator for evidence of burning or other damage.

TEST

1 Using multimeter, check supply voltage between terminals 5 and 10 of the pressure control. Supply voltage should be +24 Vdc. If supply voltage is not present, check wiring.

2 With MODE CONTROL switch positioned in MANUAL, using multimeter, check voltage between terminal 17 and ground of the pressure control. Voltage shall be 0. Turn MODE CONTROL switch to AUTO. Voltage shall be +24 Vdc. If voltages are not as stated, replace pressure regulator.

3 Using multimeter, check voltage between terminals 11 and 12 of the pressure control. Voltage shall increase from 0 to +3 Vdc as ENGINE/PUMP CONTROLLER knob is rotated from minimum to maximum. If voltage is not as stated, replace pressure regulator.

4 Using multimeter, check voltage between terminals 1 and 4 and between terminals 6 and 9. Voltage shall be +5 Vdc. If voltage is not as stated, replace pressure regulator.

3-16. CABINET ENCLOSURE REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Grinder

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Emery cloth (Item 2, Appendix C)

Paint (Item 23, Appendix C)

Wire brush

Eye protection

Respiratory protection

Personnel Required

Two

Manual References

TM 9-237

Equipment Condition Reference	Condition Description
Paragraph 2-28	Wiring, gages, switches, and indicators removed

General Safety Instructions

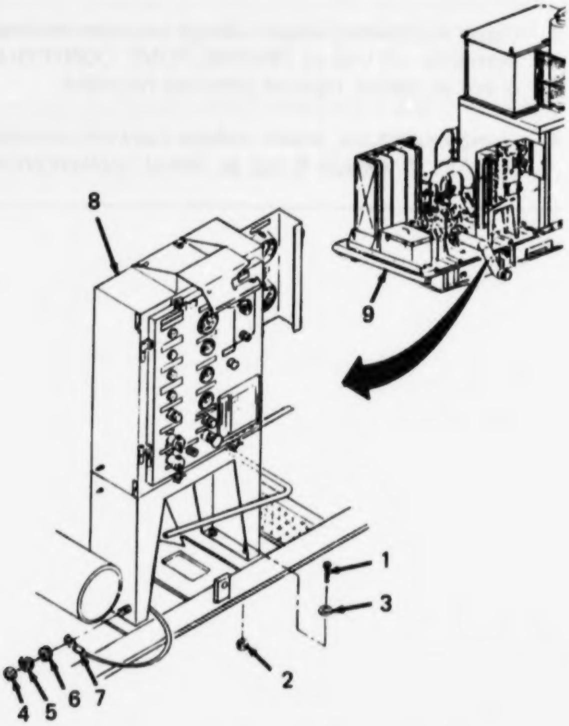
Well ventilated area required for cleaning, welding, and painting procedures.

REMOVAL:

1 Remove four capscrews (1), nuts (2), and washers (3).

2 Remove nut (4), lockwashers (5), and washers (6) securing grounding cable (7) to cabinet enclosure (8).

3 Remove cabinet enclosure (8) from skid (9).



3-16. CABINET ENCLOSURE REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean cabinet enclosure with wire brush and dry cleaning solvent to remove all traces of grease and oil. Dry with compressed air.

2 Inspect cabinet enclosure for rust spots, dents, cracks, punctures, gouges, and cracked welds.

3 Straighten out dents as necessary.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, properly tinted lenses, an apron or jacket, and welders' boots are required to avoid injury to personnel.

4 Weld cracks, punctures, or tears in sheet metal using patches on rusted through areas. Refer to TM 9-237.

WARNING

Grinding operations create airborne abrasive dust and particles. Respiratory and eye protection is required to avoid injury to personnel.

5 Grind smooth any gouges.

6 Smooth repaired areas with emery cloth and repaint.

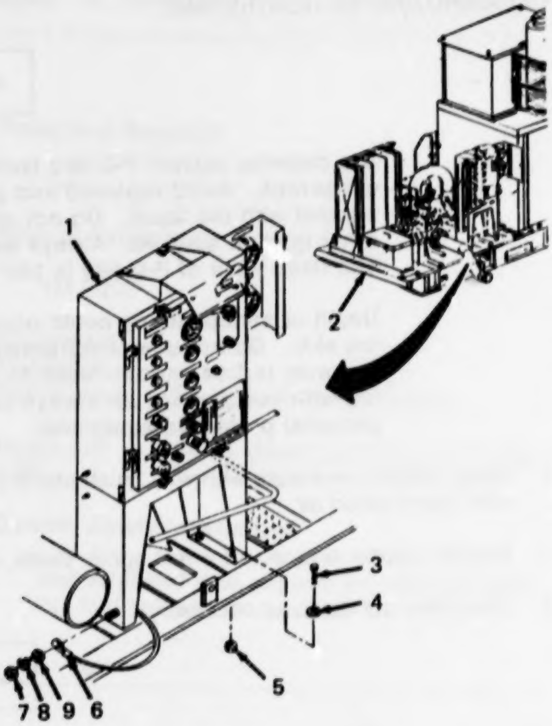
3-16. CABINET ENCLOSURE REPAIR/REPLACE (CONT)

INSTALLATION:

1 Install cabinet enclosure (1) to skid (2) using four capscrews (3), washers (4), and nuts (5).

2 Install grounding cable (6) to cabinet enclosure (1) using nut (7), lockwashers (8), and washers (9).

3 Install wiring, gages, switches, and indicators in accordance with paragraph 2-28.



3-17. NETWORK CABLE REPAIR

This task covers: a. Removal b. Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Insulating tape (Item 32, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-33	Network cable removed from pumping assembly

General Safety Instructions

Well ventilated area required for soldering procedures.

REMOVAL:

Remove damaged cable(s) from network cable.

REPAIR:

Repair of cables consists of splicing; replacement of damaged flex conduit, terminal lugs, and connections; and soldering of damaged components.

INSTALLATION:

1 Install repaired cables into network cable.

2 Install network cable to pumping assembly in accordance with paragraph 2-33.

3-18. SPEED INCREASER ADJUST/REPAIR/REPLACE

This task covers: a. Adjustment b. Removal c. Cleaning/Inspection/Repair d. Installation

INITIAL SETUP

Tools

Suitable lifting device

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Manual References

TM 5-4320-307-10

Materials/Parts

Suitable blocks

Equipment Condition Reference	Condition Description
Paragraph 3-7	Flexible coupling removed
Paragraph 2-34	Heat exchanger removed

General Safety Instructions

Insure proper lifting methods and procedures

Well ventilated area

ADJUSTMENT:

CAUTION

Ensure engine is off prior to adjusting the clutch.

NOTE

Do not adjust the clutch too tight. Forces above maximum can cause clutch component failure.

1 Ensure engine is off and in a safe condition prior to adjusting clutch assembly. Refer to TM 5-4320-307-10.

3-18. SPEED INCREASER ADJUST/REPAIR/REPLACE (CONT)

2 Remove instruction cover plate (1) by removing two screws (2).

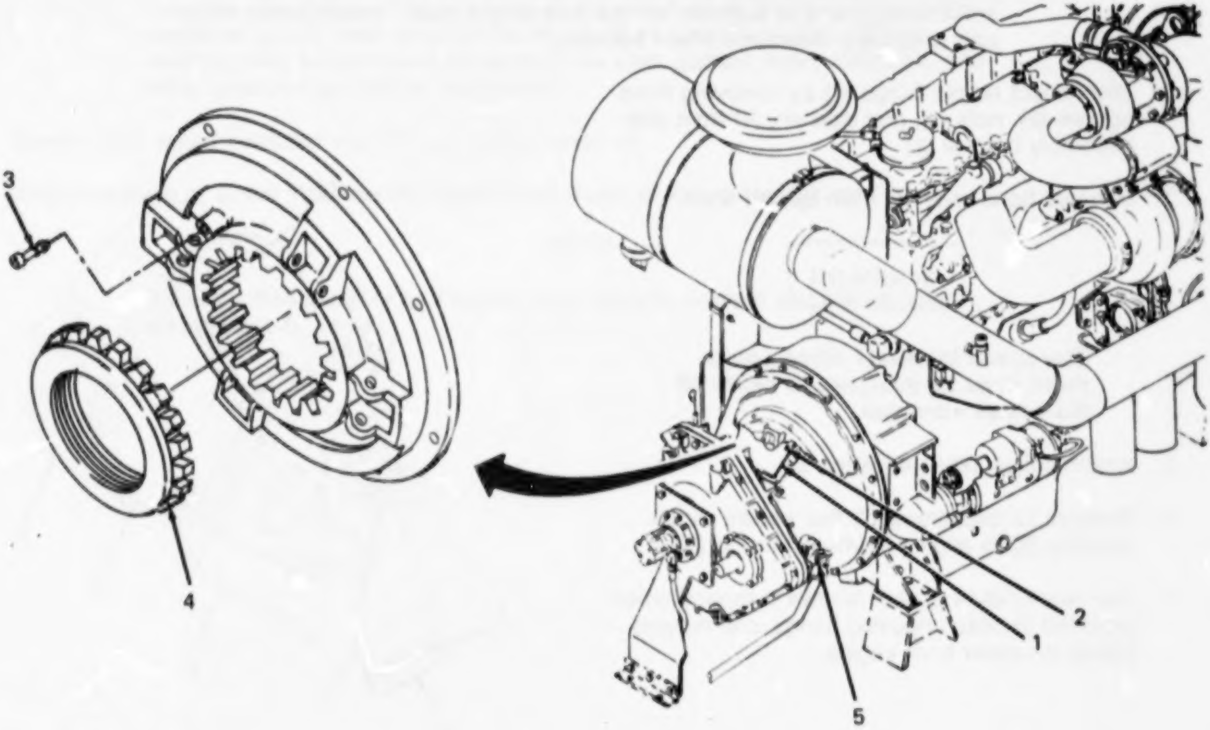
3 Turn clutch until adjusting lock pin (3) can be reached.

4 Disengage adjusting lock pin (3) by pressing pin with a screwdriver and holding it in pressed position.

NOTE

The original hand lever has a cast, hex adapter onto which a socket can be placed and a torque wrench used to check the operating shaft torque.

5 Turn adjusting ring (4) clockwise to tighten clutch. Torque operating shaft (5) to 218 to 289 ft-lbs (296 to 392 N•m) torque to engage clutch.



3-18. SPEED INCREASER ADJUST/REPAIR/REPLACE (CONT)

REMOVAL:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting ball assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Disconnect output flange (1) by removing three screws (2), nuts (3), and washers (4) from skid assembly bracket (5).

2 Remove hand lever (6) from splined shaft.

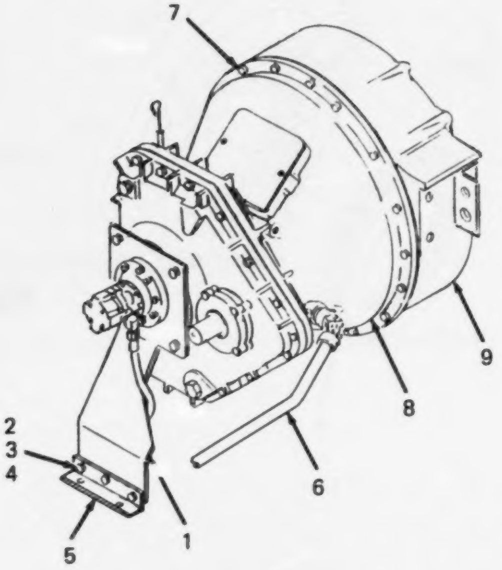
WARNING

The speed increaser lifting equipment must be designed to safely lift the speed increaser.

3 Attach proper lifting equipment.

4 Remove 12 capscrews (7) that secure clutch housing (8) to engine flywheel housing (9).

5 Use two 7/16-14 pusher screws in tapped holes provided in clutch housing flange, and remove speed increaser from engine.



3-18. SPEED INCREASER ADJUST/REPAIR/REPLACE (CONT)

6 Remove eight capscrews that secure driving ring to engine flywheel. Remove driving ring.

7 Support speed increaser clutch housing on a work bench with wooden blocks. Have clutch end facing upward.

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean speed increaser and dry with compressed air.

2 Inspect outside of speed increaser for cracks, bent studs, or excessive leakage.

NOTE

If further disassembly and repair is necessary, contact general support maintenance.

3-18. SPEED INCREASER ADJUST/REPAIR/REPLACE (CONT)

INSTALLATION:

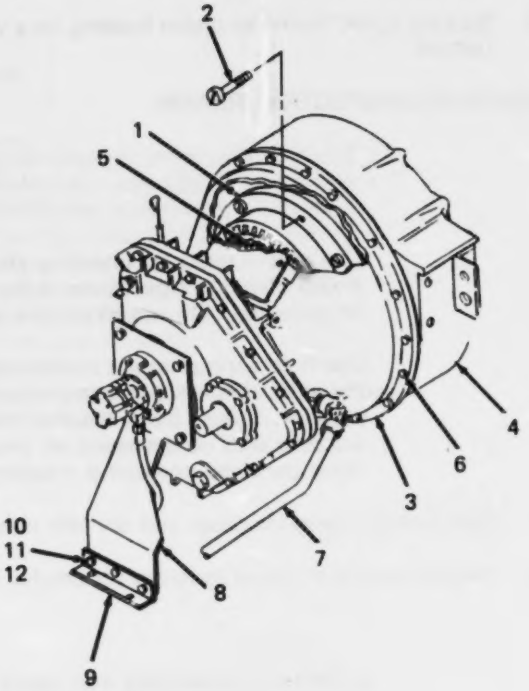
1 Position driving ring (1) against engine flywheel and secure it with eight capscrews (2).

2 Position speed increaser clutch housing (3) against engine flywheel housing (4), carefully aligning clutch driving plates (5) with driving ring (1).

3 Secure speed increaser clutch housing (3) to flywheel housing (4) with the 12 capscrews (6).

4 Install hand lever (7) to splined shaft.

5 Secure output flange (8) to skid assembly bracket (9) by installing three screws (10), washers (11), and nuts (12).



6 Install heat exchanger in accordance with paragraph 2-34.

7 Install flexible coupling in accordance with paragraph 3-7.

3-19. RADIATOR ASSEMBLY REPAIR

This task covers: Cleaning/Inspection/Repair

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Radiator repair kit

Manual References

TM 750-254

Equipment Condition Reference	Condition Description
Paragraph 2-35	Radiator assembly removed and disassembled

CLEANING/INSPECTION/REPAIR:

1 Clean, inspect, and repair radiator assembly in accordance with TM 750-254.

2 Assemble and test radiator assembly in accordance with paragraph 2-35.

3-20. ENGINE ASSEMBLY REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable lifting device

Suitable engine support stand

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Emery cloth (Item 2, Appendix C)

Paint (Item 23, Appendix C)

Eye protection

Wire brush

Personnel Required

Two

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-23	Engine enclosure removed
Paragraph 2-35	Radiator assembly removed
Paragraph 3-18	Speed increaser removed
Paragraph 2-39	Turbocharger plumbing and oil feed lines removed
Paragraph 2-33	Network cable removed at engine
Paragraph 2-30	Field instrument layout removed at engine
Paragraph 2-31	Conduit layout removed at engine
Paragraph 2-55	Oil drain assembly oil hose removed from engine
Paragraph 2-21	Feeding system disconnected at fuel filter assembly
Paragraph 3-28	Fuel return line disconnected at fuel tubing

General Safety Instructions

Well ventilated area for engine cleaning and test run

3-20. ENGINE ASSEMBLY REPLACE (CONT)

REMOVAL:

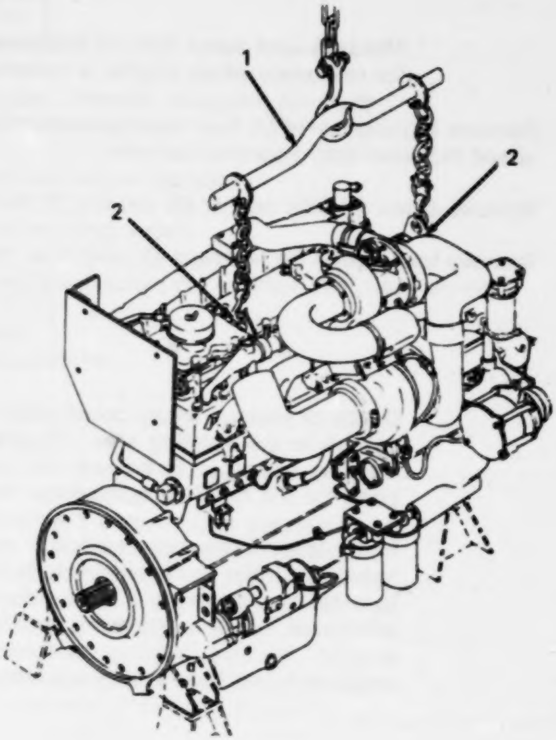
WARNING

The engine lifting equipment must be designed to safely lift the engine.

1 Position a hoist with minimum rating of 3500 lb (1590 kg) with engine lifting fixture (1) attached over engine assembly.

2 Attach fixture (1) hooks to engine lifting brackets (2).

3 Take up slack in hoist chain without applying a lifting force to engine assembly



3-20. ENGINE ASSEMBLY REPLACE (CONT)

NOTE

Measure and make note of distance that each aligning screw is screwed in for reference when engine is installed.

4 Remove aligning screw (3) from each fan end mounting pedestal and three aligning screws (4) from each speed increaser end mounting pedestal.

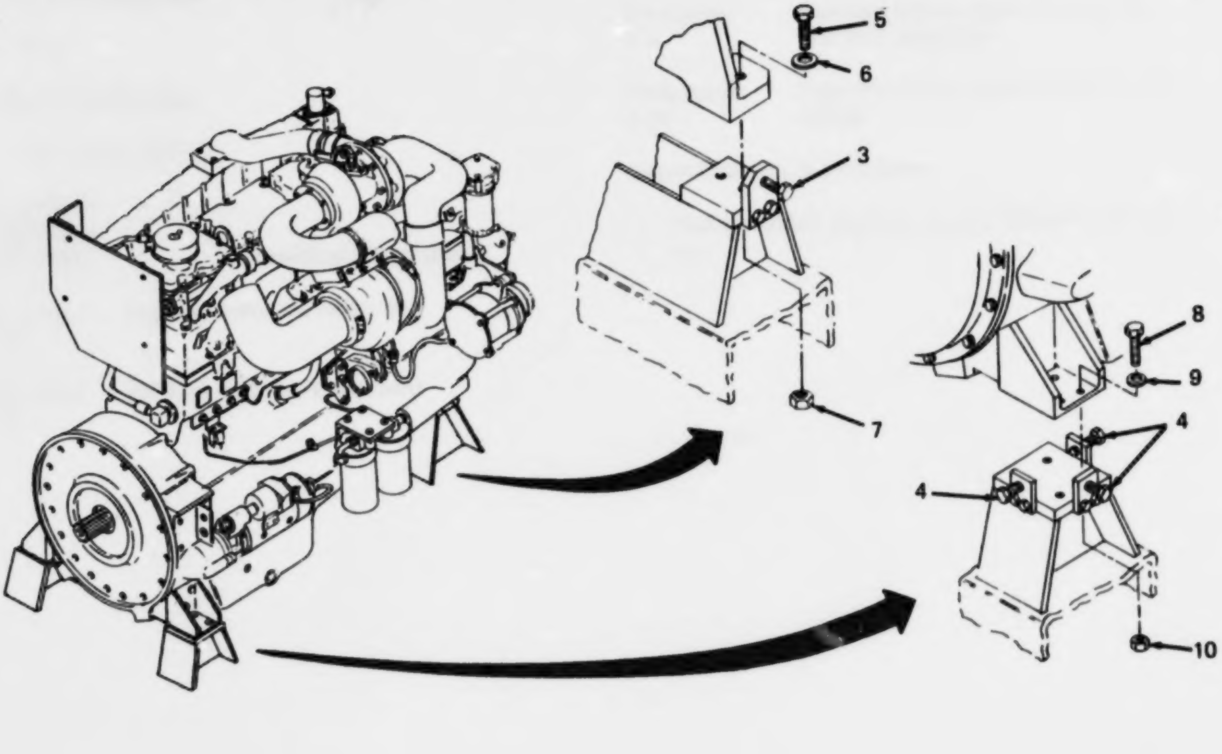
5 Remove screw (5) with washer (6) and nut (7) from each fan end mounting foot.

6 Remove four screws (8), washers (9), and nuts (10) from each speed increaser end mounting bracket.

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting brackets. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing. Watch boom angle and overhead clearance when hoisting.



3-20. ENGINE ASSEMBLY REPLACE (CONT)

CAUTION

Damage will occur if engine is set on oil pan. Provide adequate blocking to support engine after removal from trailer assembly.

7 Lifting engine assembly off skid and place on suitable engine support stands.

8 Cover all engine openings to prevent dirt and debris from entering engine.

9 Remove support bracket and other mounting brackets and accessories not supplied with replacement engine.

CLEANING/INSPECTION/REPAIR OF ENGINE MOUNTING PARTS:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean support bracket and mounting brackets on engine and corresponding mounting pads on skid with dry cleaning solvent and a wire brush and dry with low pressure compressed air.

2 Inspect all components for cracks, distortion, and elongated mounting holes. Replace components with visible damage.

3 Inspect area around each mounting hole for minute cracks using MIL-L-6868 magnetic particle inspection. If any cracks are found, replace component.

4 Repair any minor damage, nicks, burrs; remove rust, or corrosion on support bracket and mounting brackets.

5 Smooth repaired areas with emery cloth and repaint.

3-20. ENGINE ASSEMBLY REPAIR (CONT)

INSTALLATION:

1 Install engine mounting brackets (1 and 2) to engine assembly (3).

2 Install all other mounting brackets and accessories which were removed during engine removal procedure.

WARNING

The engine lifting equipment must be designed to safely lift the equipment.

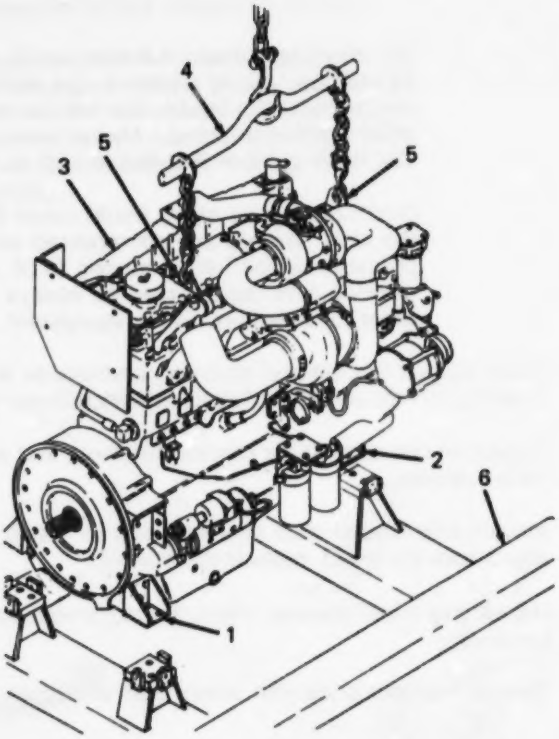
3 Position a hoist having a minimum rating of 3500 lb (1590 kg), with engine lifting fixture (4) over engine assembly (3).

4 Attach hooks of lifting fixture (4) to engine lifting brackets (5).

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting brackets. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing. Watch boom angle and overhead clearance when hoisting.



5 Lift engine assembly over skid (6) and position engine mounting brackets (1 and 2) over mounting areas on skid.

6 Gently lower engine assembly (3) onto skid (6), retaining slight tension on hoist to allow engine movement to align mounting holes.

3-20. ENGINE ASSEMBLY REPLACE (CONT)

7 Install screw (7) with washer (8) and nut (9) hand tight through each foot of fan end engine mounting bracket (2).

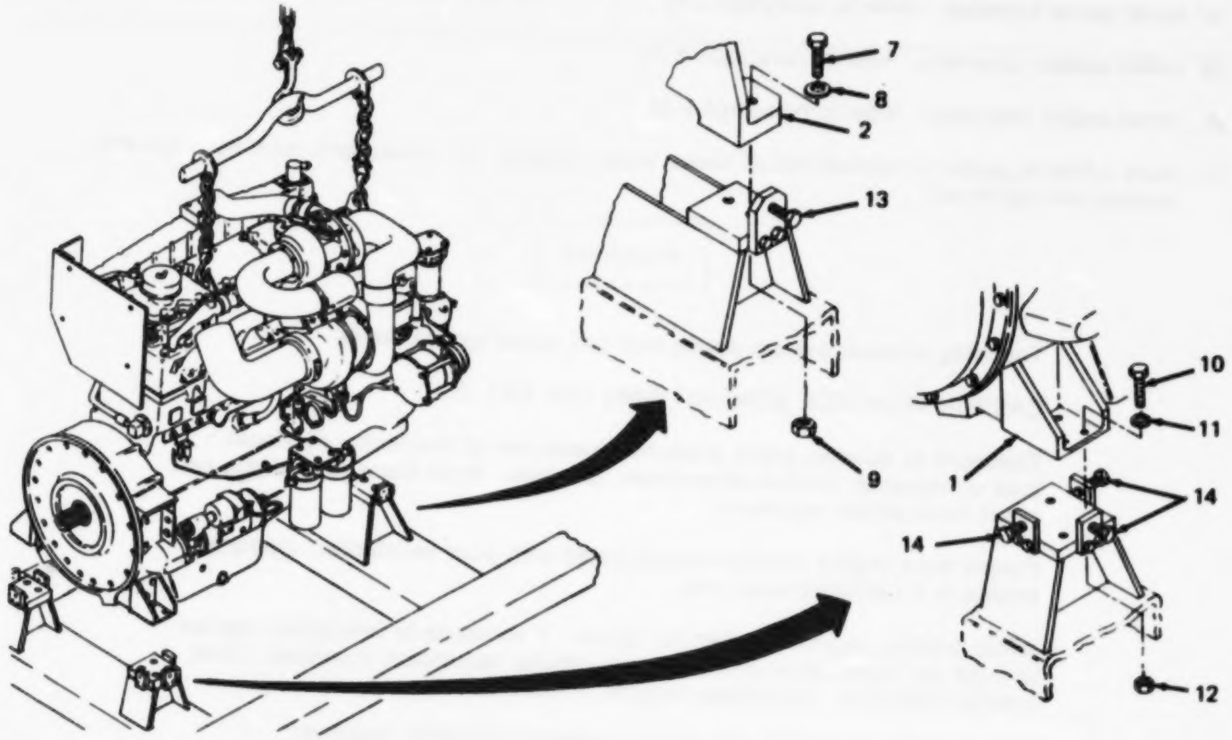
8 Install four screws (10), washers (11), and nuts (12) hand tight through each speed increaser end engine mounting bracket (1).

9 Install aligning screw (13) at each fan end mounting pedestal and three aligning screws (14) at each speed increaser and mounting pedestal.

NOTE

Screw aligning screws into distance noted during engine removal procedure.

10 Gradually tighten mounting screws (7, 10) to 123 ft-lbs (167 N-m), torquing alternately.



3-20. ENGINE ASSEMBLY REPLACE (CONT)

11 Connect fuel supply and return lines and fittings. Refer to paragraph 3-28.

12 Connect oil drain assembly oil hose. Refer to paragraph 2-55.

13 Fill engine lubricating oil sump. Refer to paragraph 2-36.

14 Install conduit layout to engine. Refer to paragraph 2-31.

15 Install infield instrument layout to engine. Refer to paragraph 2-30.

16 Install network cable. Refer to paragraph 2-33.

17 Install turbocharger plumbing and oil feed lines. Refer to paragraph 2-39.

18 Install speed increaser. Refer to paragraph 3-18.

19 Install radiator assembly. Refer to paragraph 2-35.

20 Install engine enclosure. Refer to paragraph 2-23.

21 Make a final inspection to ensure that all hoses, wires, linkages, and components have been correctly installed and tightened.

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine is a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

22 Start engine in accordance with TM 5-4320-307-10 and operate at low idle for 2 to 3 minutes.

3-20. ENGINE ASSEMBLY REPLACE (CONT)

WARNING

Do not remove the radiator cap from a hot engine. Hot steam can cause serious personal injury. The engine coolant temperature must be below 160°F (70°C).

23 Stop engine and wait 5 to 7 minutes for oil to drain into oil pan. Check oil and coolant levels again.

24 Fill engine to correct oil and coolant levels if necessary.

25 Operate engine for 5 to 10 minutes to check for correct engine operation; unusual noises; and coolant, fuel, or lubricating oil leaks.

26 Repair all leaks and component problems.

3-21. ALTERNATOR REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Test d. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Multimeter (Item 12, Appendix B)

Materials/Parts

Drycleaning solvent (Item 30, Appendix C)

Equipment Condition

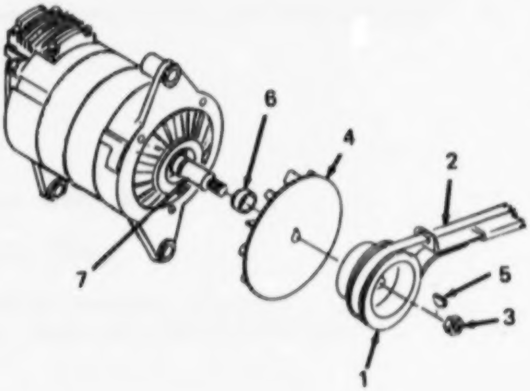
Reference	Condition Description
Paragraph 2-42	Alternator removed

General Safety Instructions

Well ventilated area required for cleaning procedures.

DISASSEMBLY:

1 Hold pulley (1) with strap wrench (2) and remove nut (3), pulley (1), fan (4), key (5), and fan spacer (6) from rotor assembly (7).



3-21. ALTERNATOR REPAIR (CONT)

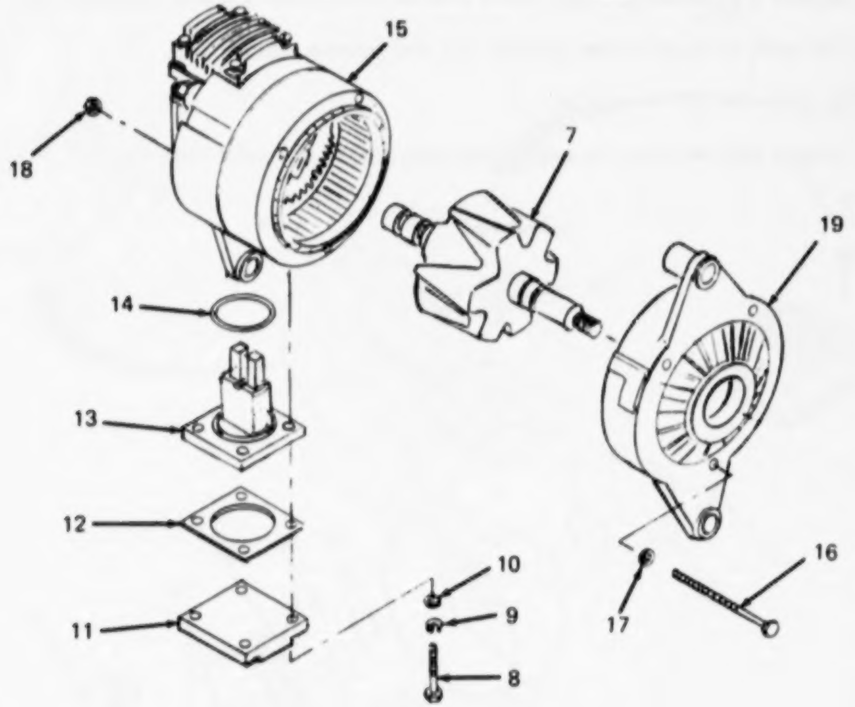
2 Remove four screws (8), lockwashers (9), and washers (10) securing cover plate (11), gasket (12), brush holder (13), and O-ring (14) to slip ring and housing (15).

3 Remove three bolts (16), washers (17), and nuts (18) and remove drive and housing (19) from slip ring end housing (16).

NOTE

If drive end housing does not readily separate from slip ring end housing, tap lightly with rubber hammer.

4 Remove rotor (7) from drive end housing (19).



3-21. ALTERNATOR REPAIR (CONT)

5 Remove four screws and lockwashers (20) securing voltage regulator (21) and gasket (22) to slip ring end housing (15).

6 Remove three locknuts (23); tag and remove AC terminals and stator (24).

7 Tag and remove remaining terminals.

8 Remove nuts (25) from output terminals (26).

9 Remove screws (27), insulation bushings (28), and washers (29) from rectifier assemblies (30) and remove rectifier assembly and regulator holder (31).

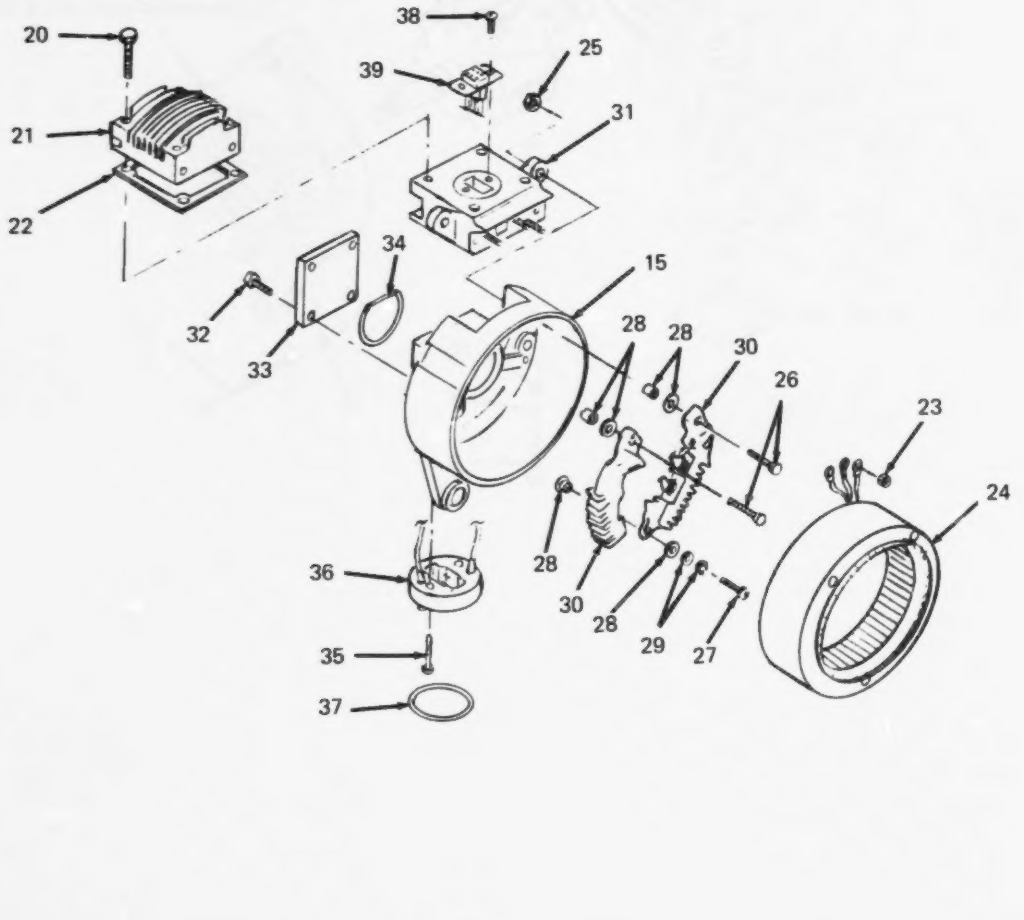
10 Remove four screws (32) securing cover plate (33) and O-ring (34) to slip ring end housing (15).

11 Remove two screws (35) securing brush holder adapter (36) to slip ring end housing (15).

12 Cut terminals off ends of brush holder adapter (36) and remove adapter.

13 Remove rubber grommet (37) from hole.

14 Remove two screws (38) securing connector assembly (39) to regulator holder (31).

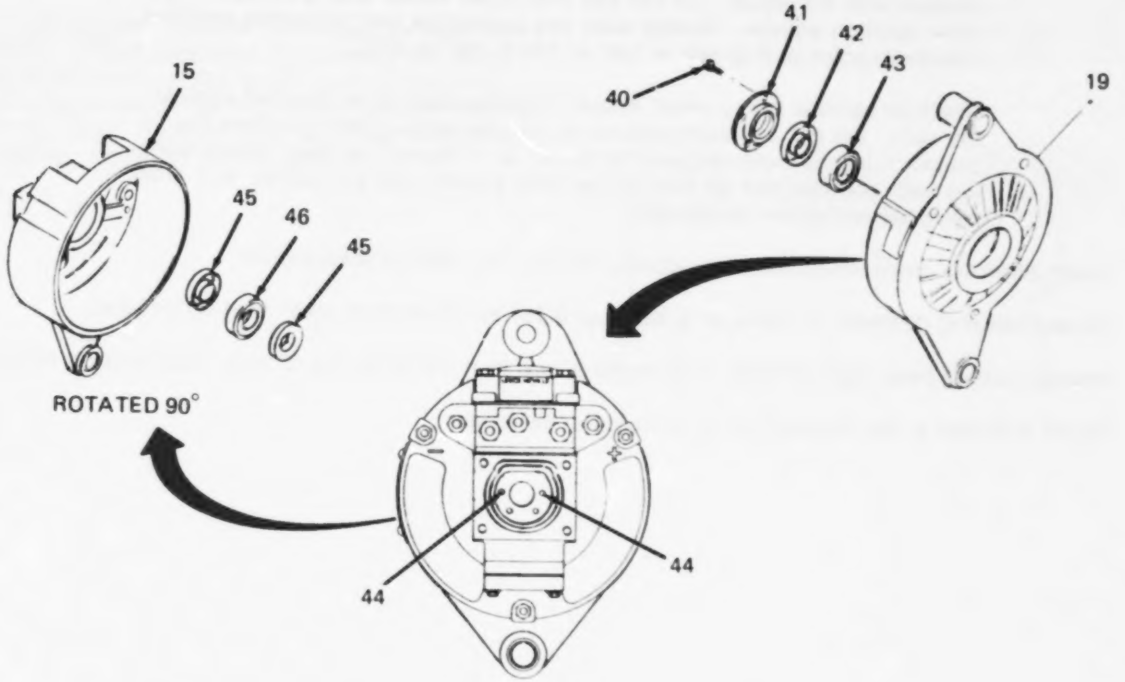


3-21. ALTERNATOR REPAIR (CONT)

15 Remove four screws (40) securing bearing retainer (41) to drive end housing (19).

16 Press out drive end bearing (42) and seal (43).

17 Insert proper size punch in one of the pilot holes (44) in the slip ring end housing (15) and knockout seals (45) and bearings (46).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3-21. ALTERNATOR REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean alternator components with dry cleaning solvent. Dry with compressed air.

2 Inspect slip ring diameter. If diameter is less than 0.767 in. (19.48 mm), rotor must be replaced.

3 Inspect bearing inner race diameter. If diameter is less than 0.8709 in. (22.12 mm), rotor must be replaced.

4 Repair is limited to the replacement of damaged components.

3-21. ALTERNATOR REPAIR (CONT)

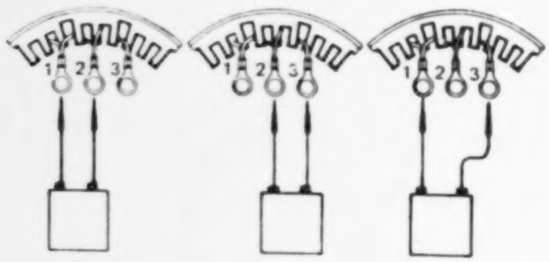
TEST:

1 Perform stator ground test by checking each of three stator leads to ground. If a low resistance is indicated, the stator is grounded and must be replaced.

2 Perform stator phase resistance test by checking resistance between each of the stator terminals 1 and 2, 2 and 3, and 1 and 3. Resistance shall be between 0.115 ohm and 0.125 ohm. If resistance values measured are not within tolerances, stator must be replaced.

3 Check diodes in rectifier assemblies by using ohmmeter. Check resistance by reversing ohmmeter leads between rectifier eyelets and rectifier case. Resistance should be high in one position and low in the other. Replace diode assembly if resistance readings observed are not as stated.

STATOR PHASE TEST

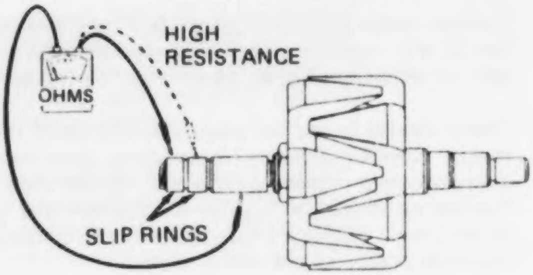


3-21. ALTERNATOR REPAIR (CONT)

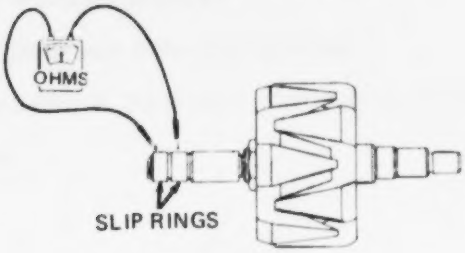
4 Perform rotor coil resistance test by checking resistance between slip rings and ground. If a low resistance is observed, the rotor assembly must be replaced.

5 Perform rotor coil resistance test by connecting ohmmeter test leads to slip rings. Resistance measurement should be between 12.5 ohms and 13.5 ohms. Replace rotor assembly if resistance readings observed are not as stated.

ROTOR COIL GROUND TEST



ROTOR COIL RESISTANCE TEST



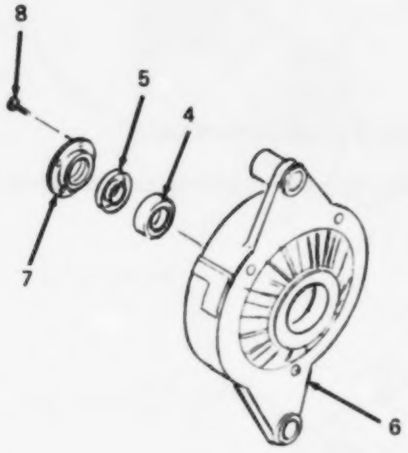
3-21. ALTERNATOR REPAIR (CONT)

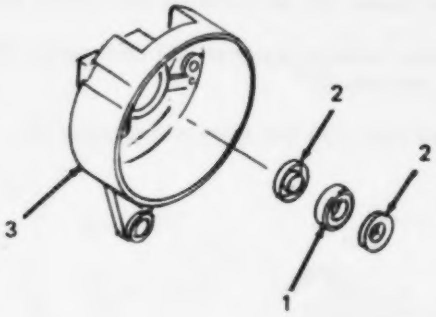
ASSEMBLY:

1 Press bearing (1) and seals (2) in slip ring end housing (3).

2 Press in drive end bearing (4) and seal (5) and drive end housing (6).

3 Position bearing retainer (7) on drive end housing and secure using four screws (8).





3-21. ALTERNATOR REPAIR (CONT)

4 Position connector assembly (9) on regulator holder (10) and secure using two screws (11).

5 Install brush holder adapter (12) and install terminal ends.

6 Position brush holder adapter (12) in slip ring end housing (3) and secure using two screws (13).

7 Position cover plate (14) and O-ring (15) on slip ring end housing (3) and secure using four screws (16).

8 Install regulator holder (10) and rectifier assemblies (17) and secure using washers (18), insulation bushings (19), and screws (20).

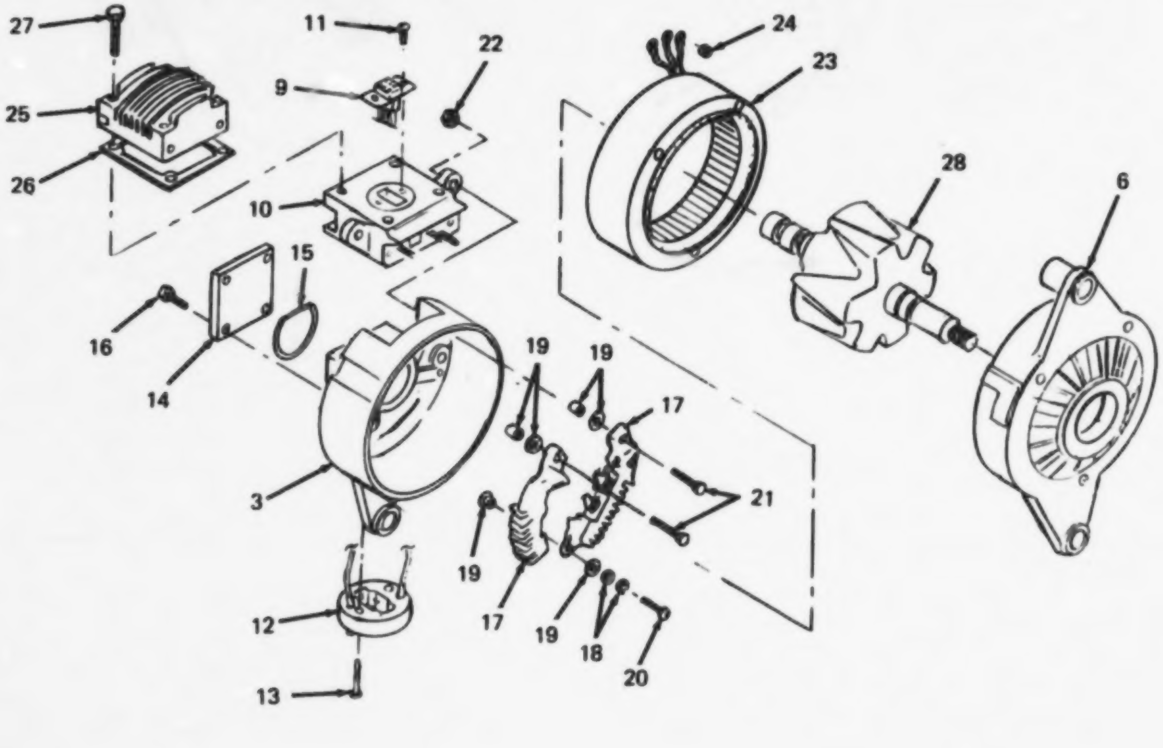
9 Install output terminals (21) and nuts (22).

10 Install terminals and remove tags.

11 Install stator (23) ac terminals and secure using three locknuts (24) and remove tags.

12 Position voltage regulator (25) and gasket (26) on slip ring end housing (3) and secure using four screws and washers (27).

13 Install rotor (28) into drive end housing (6).

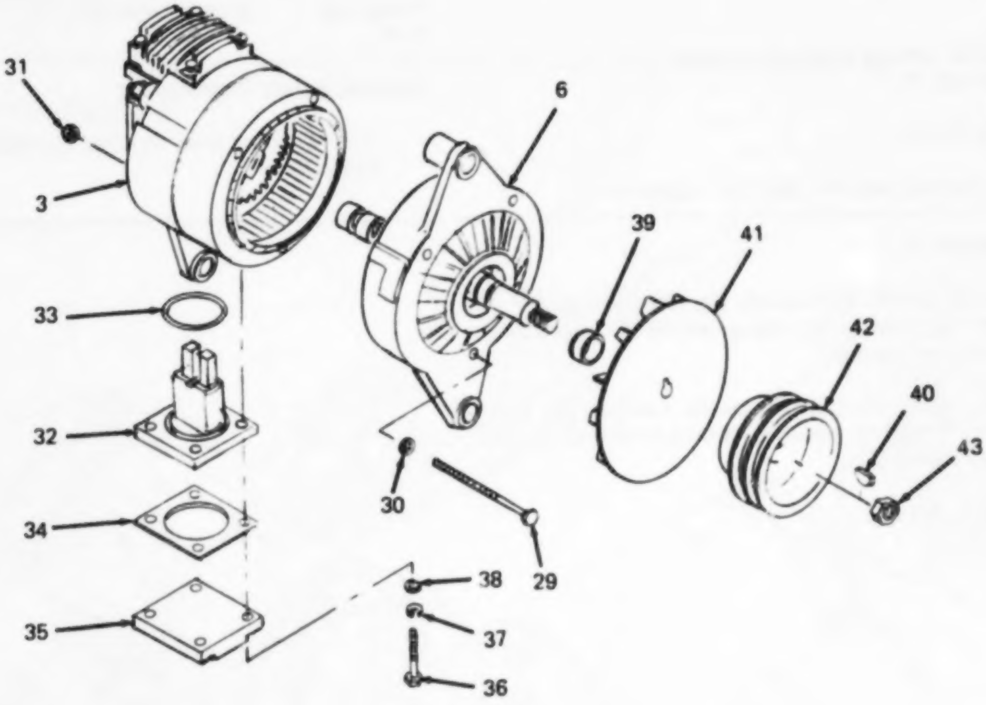


3-21. ALTERNATOR REPAIR (CONT)

14 Install drive end housing (6) onto slip ring end housing (3) and secure using three bolts (29), washers (30), and nuts (31).

15 Position brush holder (32), O-ring (33), gasket (34), and cover plate (35) on slip ring end housing (3) and secure using four screws (36), lockwashers (37), and washers (38).

16 Install fan spacer (39), key (40), fan (41), pulley (42), and secure using nut (43).



3-22. STARTER MOTOR REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Test d. Assembly

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-43	Starter removed

General Safety Instructions

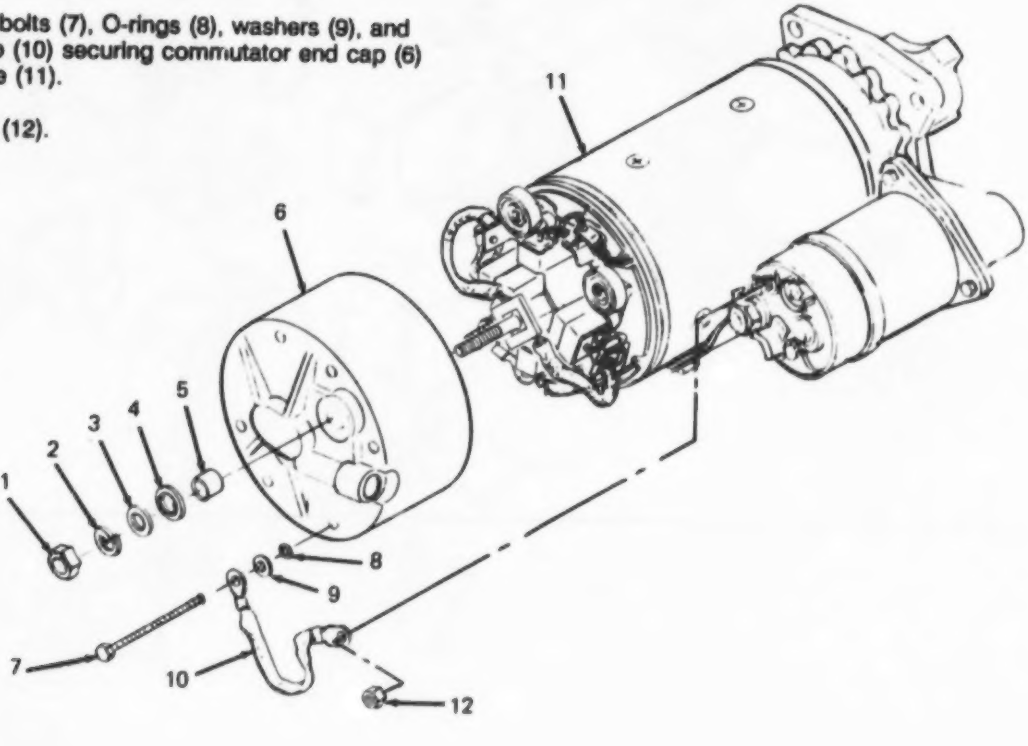
Well ventilated area required for cleaning procedures

DISASSEMBLY:

1 Remove nut (1), lockwasher (2), thin washer (3), insulating bushing (4), and grommet (5) from commutator end cap (6).

2 Remove six bolts (7), O-rings (8), washers (9), and ground strap (10) securing commutator end cap (6) to field frame (11).

3 Remove nut (12).



3-22. STARTER MOTOR REPAIR (CONT)

4 Remove two screws (13) securing wires (14) to brush plate assembly (15). Tag wires and remove brush plate assembly from field frame.

5 Disassemble brush spring plate (15) as follows:

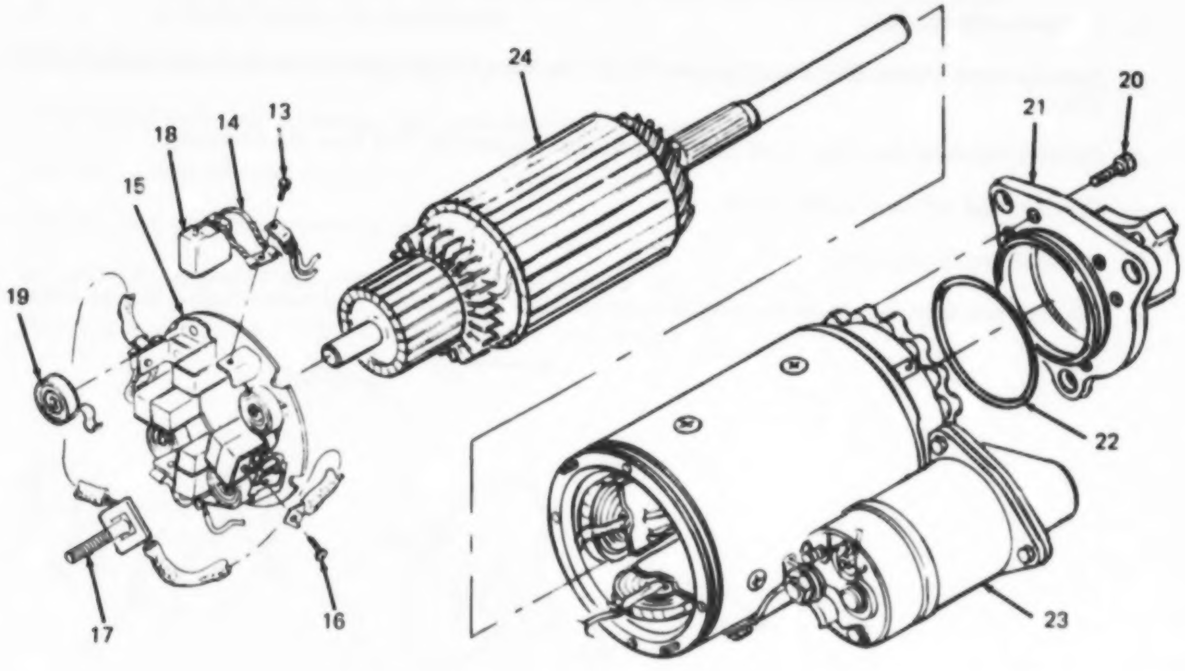
   a. Remove two screws (16) securing terminal post assembly (17) to brush spring plate assembly (15).

   b. Remove brushes (18) from spring plate assembly.

   c. Remove springs (19).

6 Remove six screws (20) securing nose housing (21) and O-ring (22) to lever housing (23).

7 Remove armature (24).



3-22. STARTER MOTOR REPAIR (CONT)

8 Remove five bolts (25) securing lever housing (23) to field frame (11) and separate lever housing from field frame.

9. Disassemble field frame (11) as follows:

   a. Remove screw (26) securing connector strap (27) to field frame (11) and remove connector strap.

   b. Remove two screws (28) securing each coil retainer (29) to field frame and remove coil retainers and coils.

   c. Remove two spring pins (30), grommet (31), and O-ring (32) from field frame (11).

10 Disassemble lever housing (23) as follows:

   a. Remove plug (33) and gasket (34) from lever housing (23).

   b. Remove shaft nut (35).

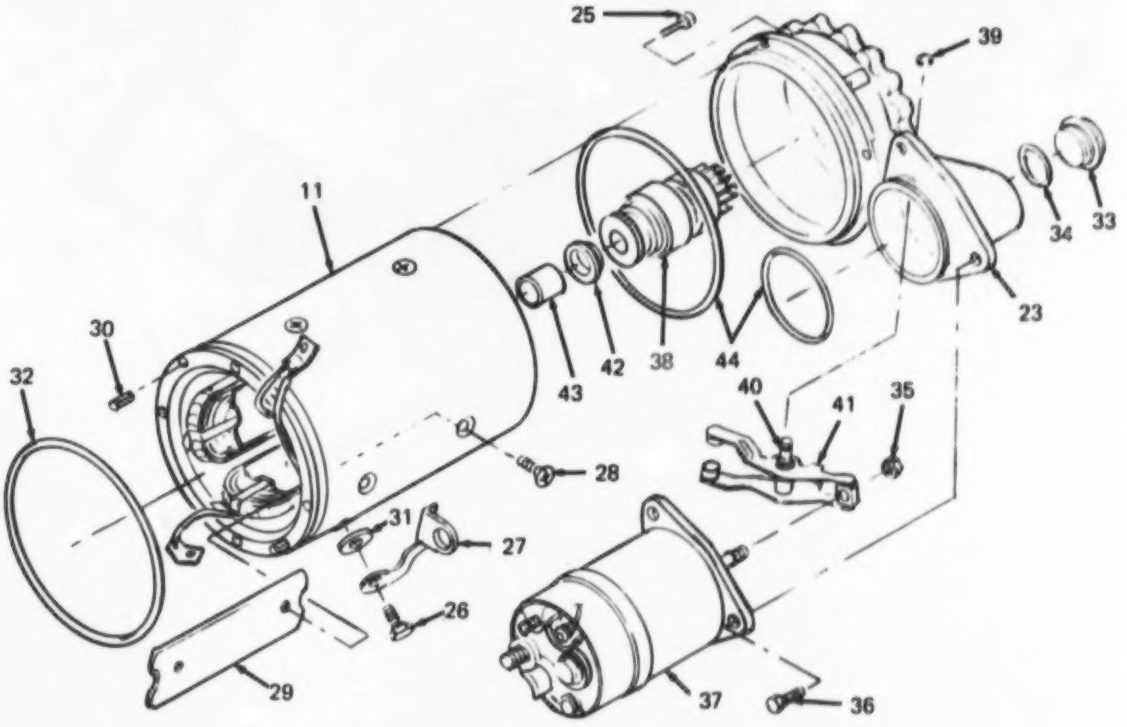
   c. Remove three screws (36) securing solenoid (37) to lever housing (23) and remove solenoid and drive (38).

   d. Remove retaining ring (39), pivot rod (40), and shift mechanism (41) from lever housing.

   e. Remove seal (42) and bushing (43).

   f. Remove two O-rings (44).

   g. Remove bushings from lever housing (23), commutator end cap (6), and nose housing (21) as required.



3-22. STARTER MOTOR REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean starter components with dry cleaning solvent. Dry with compressed air.

2 Inspect field frame, lever housing, and nose housing for cracks.

3 Inspect brushes for wear and cracks.

4 Inspect drive for worn, broken, or missing teeth.

5 Inspect commutator on armature for evidence of wear, arcing, or burning.

6 Repair is limited to the replacement of damaged components.

3-22. STARTER MOTOR REPAIR (CONT)

TEST:

1 Using ohmmeter, check that field coils are not grounded to field frame. Check field coils at three positions.

2 Check for continuity between solenoid terminals "S", "M", and "G". Replace solenoid if circuit is open.

3 Check armature for short circuits, opens, and grounds. Minor shorts can be repaired by cleaning out area between armature plates. If armature indicates an open or ground, replace.

3-22. STARTER MOTOR REPAIR (CONT)

ASSEMBLY:

1 Assemble lever housing (1) as follows:

a. Install bushings into nose housing (2), commutator end cap (3), and lever housing (1) as required.

b. Install two O-rings (4).

c. Install seal (5) and bushing (6).

d. Install shift mechanism (7), pivot rod (8), and retaining ring (9) into lever housing.

e. Position drive (10) and install solenoid (11) to lever housing using three screws (12).

f. Install shaft nut (13).

g. Install gasket (14) and plug (15) into lever housing (1).

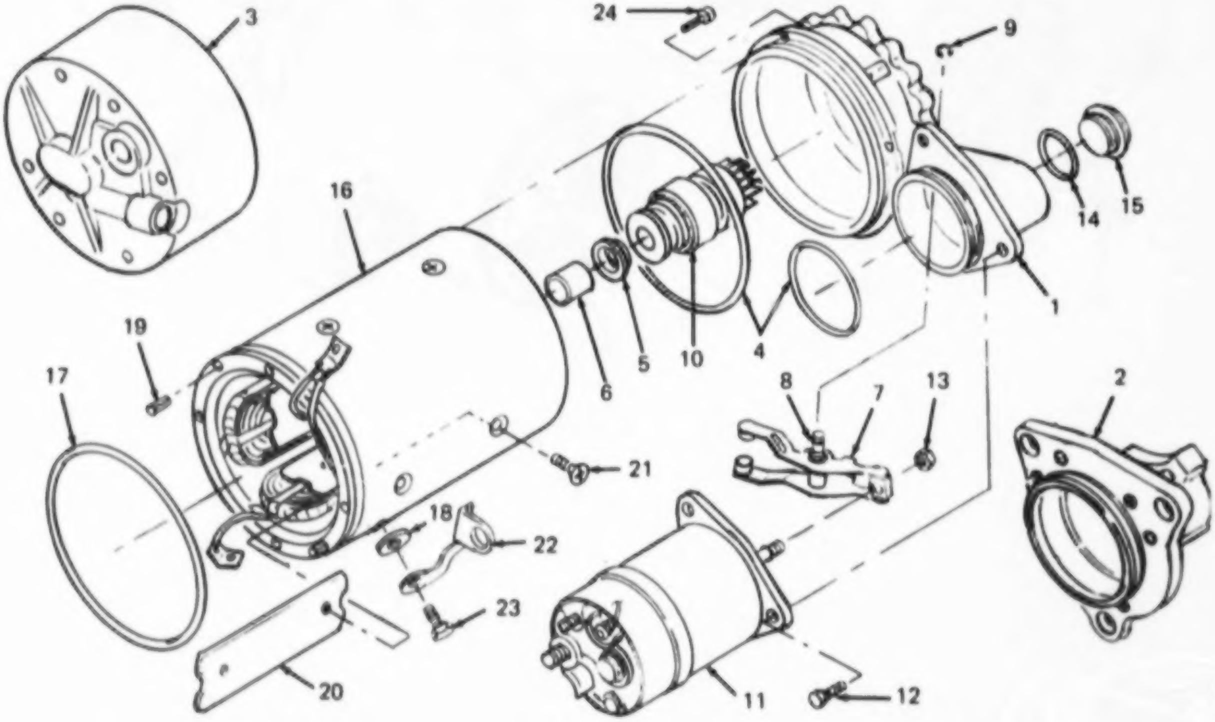
2 Assemble field frame (16) as follows:

a. Install O-ring (17), grommet (18), and two spring pins (19) onto field frame (16).

b. Position coils and coil retainers (20) on field frame and secure each using two screws (21).

c. Position connector strap (22) on field frame (16) and secure using screw (23).

3 Position lever housing (1) on field frame (16) and secure using five bolts (24).



3-22. STARTER MOTOR REPAIR (CONT)

4 Install armature (25).

5 Position nose housing (2) and O-ring (26) on lever housing (1) and secure using six screws (27).

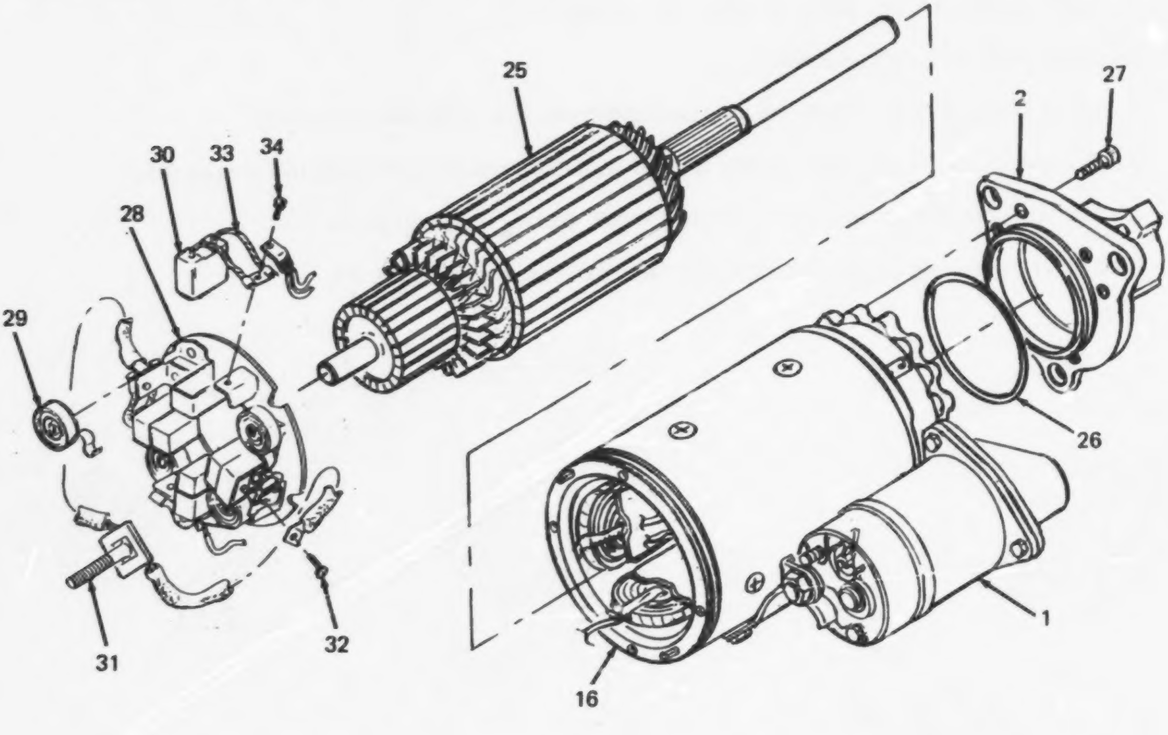
6 Assemble brush spring plate (28) as follows:

   a. Install springs (29).

   b. Install brushes (30) on spring plate assembly (28).

   c. Position terminal post assembly (31) on brush spring plate assembly (28) and secure using two screws (32).

7 Position brush spring plate assembly (28) and field frame (16) and secure wires (33) to brush spring plate assembly (28) using two screws (34). Remove tags.

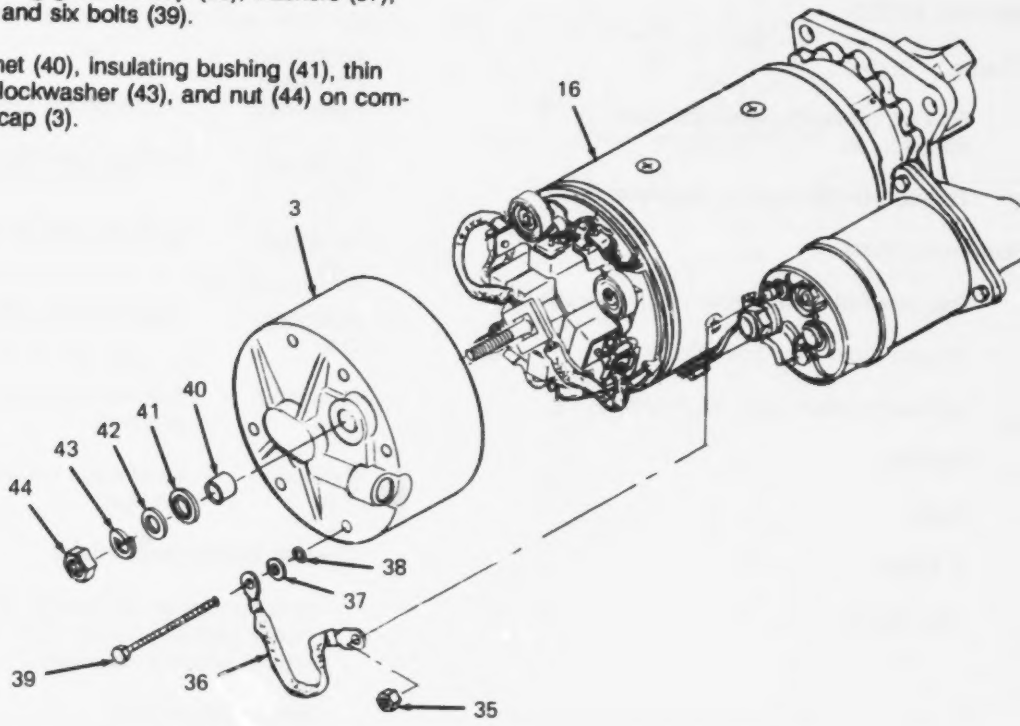


3-22. STARTER MOTOR REPAIR (CONT)

8 Install nut (35).

9 Install commutator end cap (3) to field frame (16) and secure using ground strap (36), washers (37), O-rings (38), and six bolts (39).

10 Install grommet (40), insulating bushing (41), thin washer (42), lockwasher (43), and nut (44) on commutator end cap (3).



3-23. WATER MANIFOLD REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Replacement d. Pressure Test

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Grease (Item 14, Appendix C)

Antiseizing tape (Item 31, Appendix C)

Gaskets

Seals

O-Rings

Wire brush

Equipment Condition Reference	Condition Description
Paragraph 2-35	Radiator assembly drain
Paragraph 2-39	Turbocharger plumbing removed
Paragraph 2-40	Turbocharger removed
Paragraph 2-44	Corrosion resistor assembly removed
Paragraph 2-45	Thermostat housing assembly removed

General Safety Instructions

Ensure coolant temperature is below 120°C (50°F) before servicing water manifold or thermostat housing assembly.

Well ventilated area

3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

REMOVAL:

1 Remove water manifold (1) as follows:

   a. Remove pipe plugs (2 and 3) from water manifold (1).

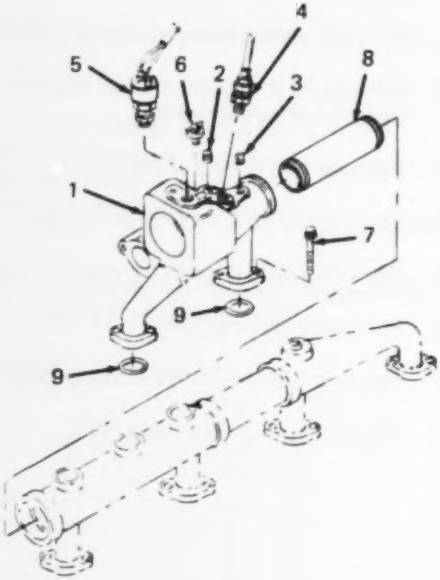
   b. Remove alarm switch (4) and temperature sending unit (5).

   c. Remove cock drain (6).

   d. Remove four capscrews (7).

   e. Remove water manifold (1) from engine and water bypass connector (8).

   f. Remove two O-ring seals (9).



3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

2 Remove water manifold (10) as follows:

a. Remove water bypass connector (8) and two O-ring seals (11) from water manifold (10).

b. Remove four capscrews and washers (12) and remove water manifold (10) from engine and water bypass connection (13).

c. Remove two O-ring seals (14).

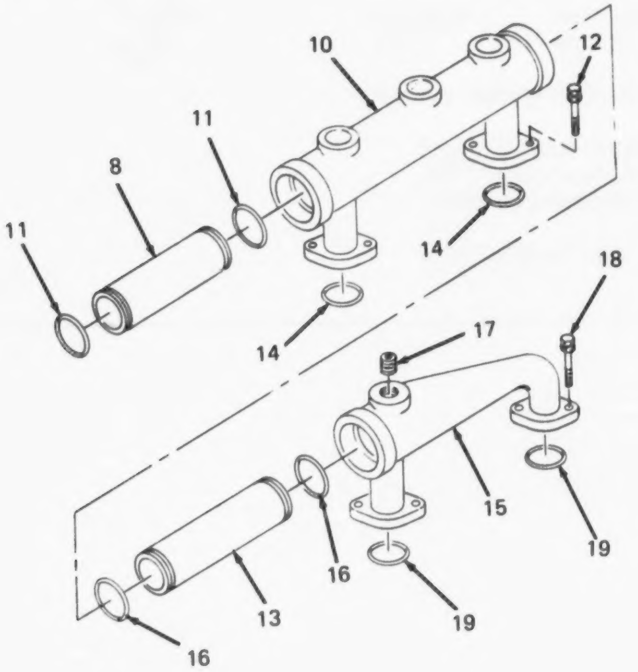
3 Remove water manifold (15) as follows:

a. Remove water bypass connection (13) and two O-ring seals (16) from water manifold (15).

b. Remove pipe plug (17).

c. Remove four capscrews and lockwashers (18) and remove water manifold (15) from engine.

d. Remove two O-ring seals (19).



3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/RPAIR:

WARNING

Dry cleaning solvent P-D-680 (Safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C)

1 Use wire brush and/or dry cleaning solvent to clean the manifold and thermostat housing. Inspect for breaks, cracks, and excessive corrosion. Repair is limited to the replacement of faulty items.

2 Inspect drain cock for proper opening and closing. Replace if defective.

3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

REPLACEMENT:

1 Install water manifold (1) as follows:

   a. Install two new ring seals (2).

   b. Install water manifold (1) on engine and install and tighten four capscrews and lockwashers (3) to 35 ft-lbs (47 N•m) torque.

   c. Wrap threads on pipe plug (4) with sealing tape and install in water manifold (1).

   d. Coat two new ring seals (5) to GAA grease and install.

   e. Install water bypass connection (6) into water manifold (1).

2 Install water manifold (7) as follows:

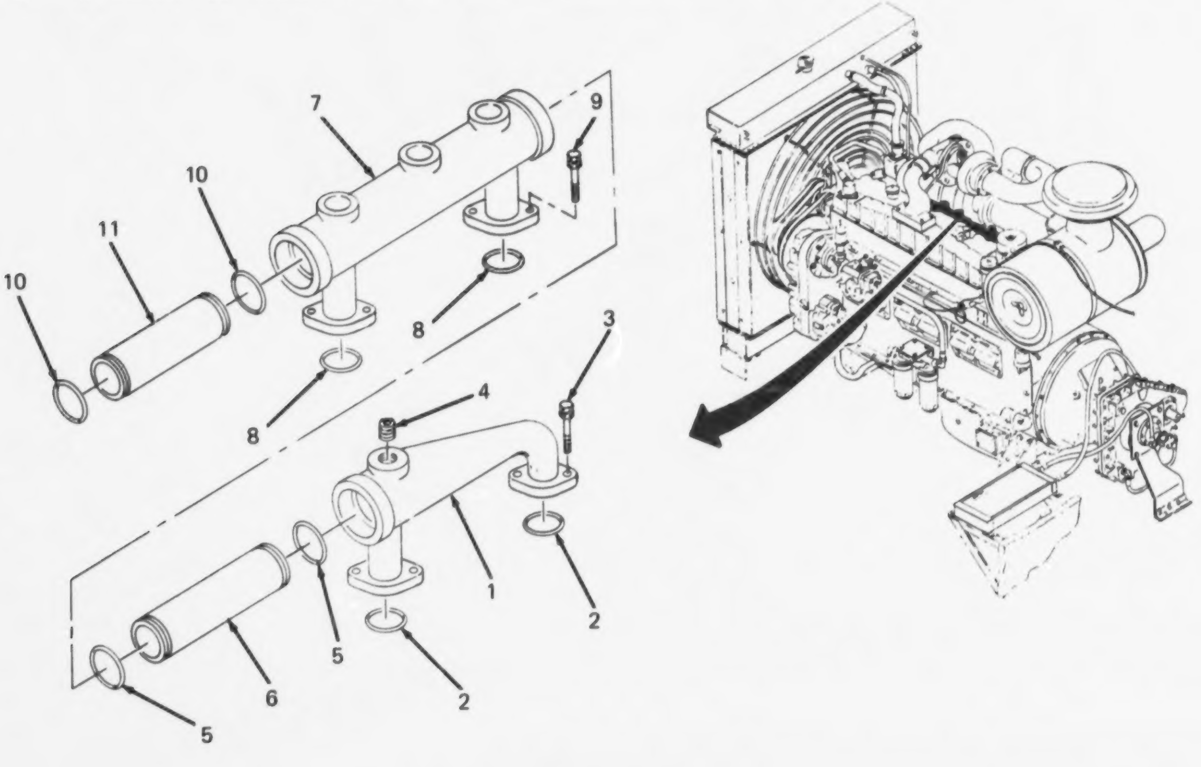
   a. Install two new ring seals (8).

   b. Install water manifold (7) on engine and into water bypass connection (6).

   c. Install and tighten four capscrews and washers (9) to 35 ft-lbs (47 N•m) torque.

   d. Coat two new O-ring seals (10) with GAA grease and install.

   e. Install water bypass connection (11) into water manifold (7).



3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

3 Install water manifold (12) as follows:

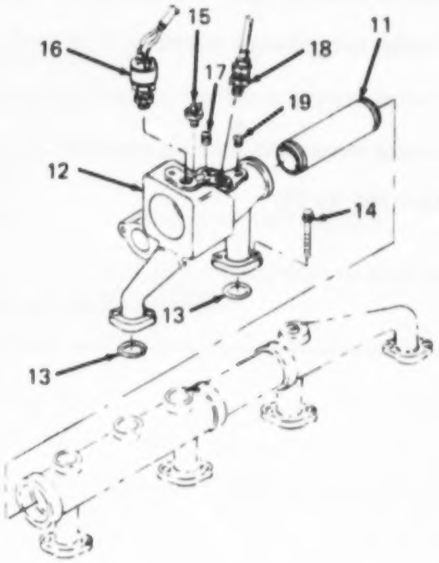
a. Install two new ring seals (13).

b. Install water manifold (12) to engine and water bypass connection (11).

c. Install and tighten four capscrews (14) to 35 ft-lbs (47 N·m) torque.

d. Wrap threads on cock drain (15) with sealing tape and install in water manifold (12).

e. Wrap threads on pipe plugs (16, 17, 18, and 19) with sealing tape and install in water manifold (12).



3-23. WATER MANIFOLD REPAIR/REPLACE (CONT)

4 Fill cooling system in accordance with paragraph 2-35.

5 Install turbochargers in accordance with paragraph 2-40.

6 Install turbocharger plumbing in accordance with paragraph 2-39.

7 Install corrosion resistor assembly in accordance with paragraph 2-44.

8 Install thermostat housing assembly in accordance with paragraph 2-45.

PRESSURE TEST:

NOTE

Pressure test the system in accordance with paragraph 2-35.

3-24. AFTERCOOLER REPAIR

This task covers: a. Inspection b. Repair

INITIAL SETUP

Test Equipment

Air pressure gauge

Suitable tank (water)

Clamps

Pipe plugs

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Radiator repair kit

Manual References

TM 750-254

Equipment Condition Reference	Condition Description
Paragraph 2-47	Aftercooler assembly removed and disassembled

INSPECTION:

1 Install hose (1), hose clamps (2), and solid pipe plug (3) on water outlet pipe.

2 Install hose (4), hose clamps (5), and water inlet tube (6) on water inlet pipe.

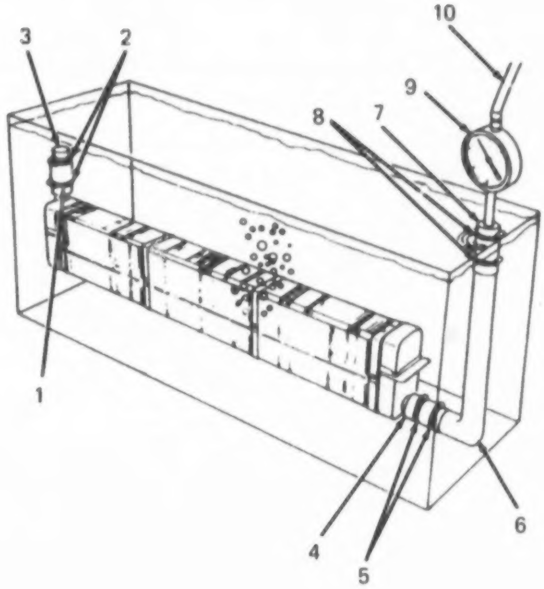
3 Install hose (7), hose clamps (8), and air pressure gauge (9) on water inlet pipe.

4 Connect air pressure gauge (9) to regulated air supply (10) and apply 40 psi air pressure.

5 Submerge core in a tank of water.

6 If air bubbles appear, core is damaged.

7 Remove core from tank and remove test equipment.



3-24. AFTERCOOLER REPAIR (CONT)

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

8 Dry with compressed air.

REPAIR:

1 Clean and repair aftercooler in accordance with TM 750-254.

2 Inspect aftercooler in accordance with aforementioned procedures.

NOTE

If core is deemed nonrepairable, replace core.

3 Assemble aftercooler in accordance with paragraph 2-47.

3-25. FAN HUB AND BRACKET REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Grease (Item 13, Appendix C)

Lubricating oil (Item 22, Appendix C)

Locknut

Retaining ring

Grease fitting

Oil seal

Dry cleaning solvent (Item 30, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-48	Fan hub and bracket removed

General Safety Instructions

Well ventilated area required for cleaning procedures

DISASSEMBLY:

1 Remove two pipe plugs (1) from fan pulley (2).

2 Remove six capscrews (3), lockwashers (4), fan pilot spacer (5), and fan spacer gasket (6).

3 Remove locknut (7) and washer (8) from shaft (9).

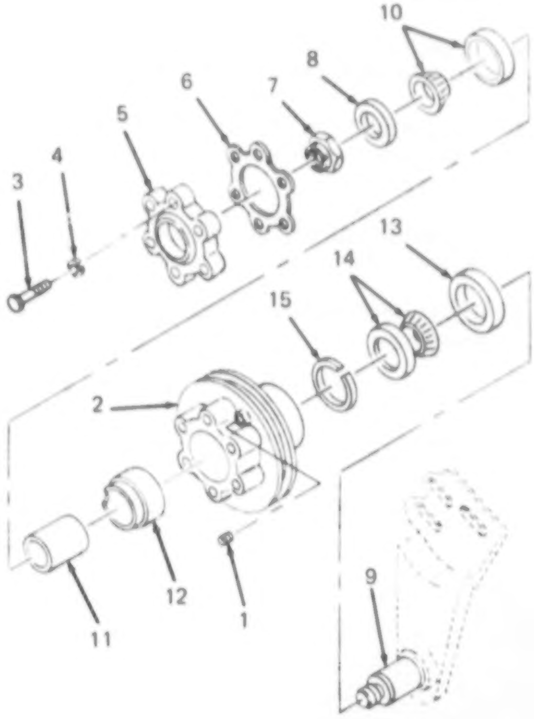
4 Remove fan pulley (2) from shaft (9).

5 To remove inner race of front bearing (10) and spacers (11 and 12) from fan pulley (2), hold a flat punch against back side of race. Hit punch with a hammer until race is loosened from bore.

6 Remove oil seal (13) and inner race of rear bearing (14).

7 To remove outer races for bearings (10 and 14), hold a flat punch against back side of race. Hit punch with a hammer until race is loosened from bore.

8 Remove retaining ring (15) from bore of fan pulley (2).



3-25. FAN HUB AND BRACKET REPAIR (CONT)

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

Do not use compressed air on bearings.

1 Clean all parts using a soft bristle brush and dry cleaning solvent. Dry with compressed air.

2 Inspect roller bearings (1 and 2) for freedom of movement, scored or cracked races, or warm rollers. If any part of bearing is damaged, replace bearing.

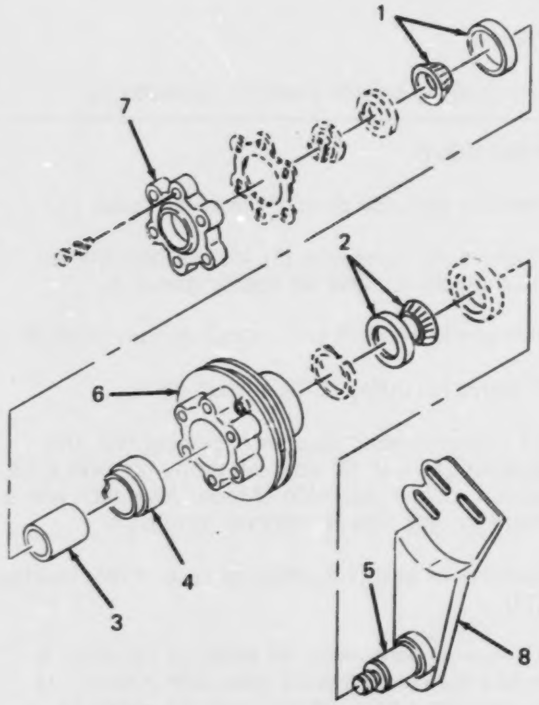
3 Inspect bearing spacers (3 and 4) for cracks or distortion. Replace spacers if damaged.

4 Inspect shaft (5) for scoring, wear, or other damage. Replace shaft if damaged.

5 Inspect fan pulley (6) for cracks or gouges. Check pulley grooves for wear or damaged. Replace pulley if damaged.

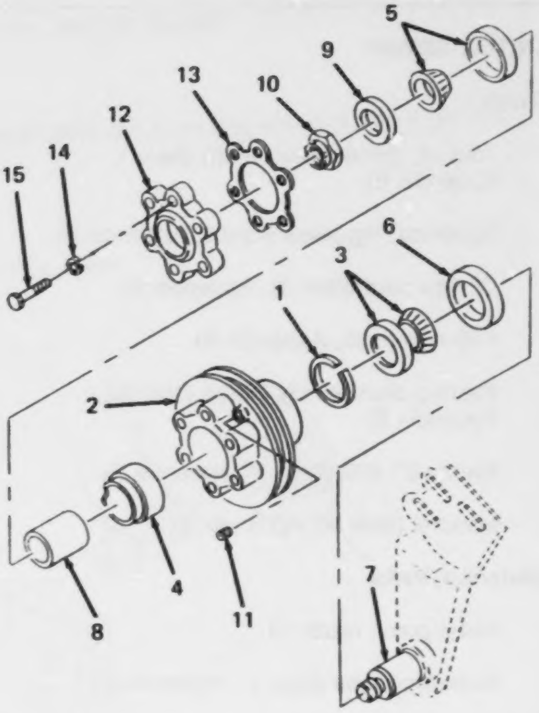
6 Inspect fan pilot spacer (7) for cracks. Replace spacer if damaged.

7 Inspect fan hub bracket (8) for cracks or other damage.



3-25. FAN HUB AND BRACKET REPAIR (CONT)

ASSEMBLY:



1 Install new retaining ring (1) into groove in fan pulley (2) bore.

2 Install outer race of roller bearing (3) into fan bracket end of fan pulley (2) bore. Push race into bore until race is against retaining ring (1).

3 Install bearing spacer (4) into opposite bore of fan pulley (2). Align holes in spacer with grease holes in hub of fan pulley.

NOTE

Do not damage retaining ring when you push the race against the spacer.

4 Install outer race of roller bearing (5) into spacer end of fan pulley (2) bore. Push race into bore until it is against retaining ring (1).

5 Lubricate rear roller bearing (3) with grease and install bearing into outer race. Push seal (6) into bore so that it is even with edge of bore or not more than 0.020 inch (0.51 mm) below edge. Make sure lip of seal is toward bearing.

6 Apply a coat of clean lubricating oil to inside diameter of seal (6). Slide shaft (7) through seal, bearing (3), and fan pulley (2).

7 Install inner spacer (8) over shaft (7) and into outer spacer (4).

8 Lubricate front roller bearing (5) with grease and install bearing into outer race.

9 Install washer (9) and locknut (10) to shaft (7). Tighten locknut to 45 to 155 ft-lbs (196 to 210 N•m) torque. Rotate fan pulley (2) while tightening locknut.

10 Install grease fitting into one of the threaded holes in fan pulley (2) and fill bore with grease until it is 60 to 70 percent full.

11 Remove grease fitting and install two pipe plugs (11). Tighten to 5 to 7 ft-lbs (7 to 10 N•m) torque.

12 Install fan pilot spacer (12), fan spacer gasket (13), using six lockwashers (14) and capscrew (15), and ship fan hub and bracket to unit maintenance.

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3-26. WATER PUMP ASSEMBLY REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Retaining ring pliers (Item 2, Appendix B)

Oil seal pilot (Item 31, Appendix B)

Puller (Item 32, Appendix B)

Bearing disassembly fixture (Item 33, Appendix B)

Fixture ST-658 (Item 34, Appendix B)

Mandrel (Item 30, Appendix B)

Materials/Parts

Water pump repair kit

Antiseizing tape (Item 31, Appendix C)

Dry cleaning solvent (Item 30, Appendix C)

Lubricating oil (Item 22, Appendix C)

Adhesive sealant (Item 3, Appendix C)

Grease (Item 15, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 2-50	Water pump assembly removed

General Safety Instructions

Well ventilated area for dry cleaning solvent use

3-26. WATER PUMP ASSEMBLY REPAIR (CONT)

DISASSEMBLY:

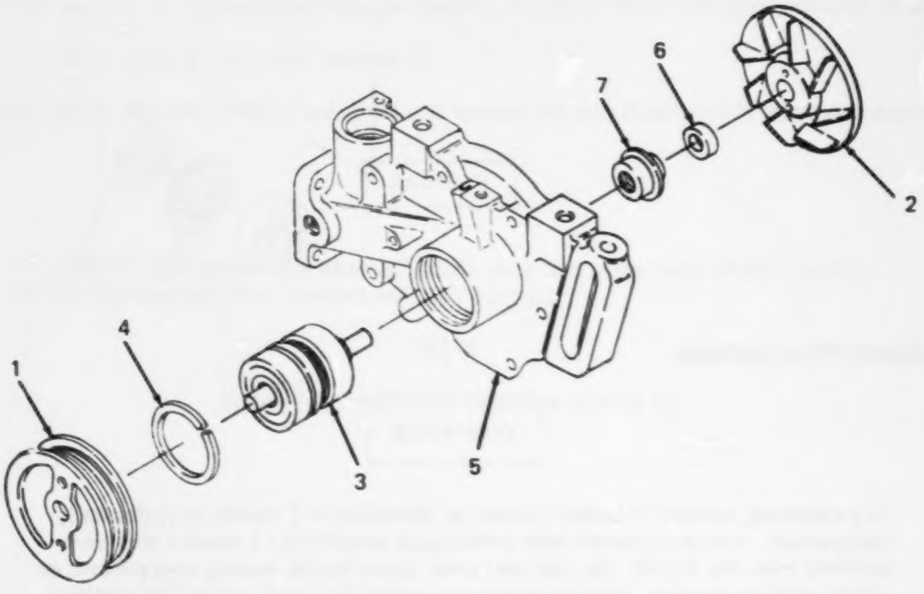
1 Use puller and remove pulley (1) and impeller (2) from shaft (3). Discard impeller.

2 Remove large retaining ring (4) and discard.

3 Support pulley side of housing (5). Push on the impeller end of shaft (3) to remove bearings and shaft from housing (5).

4 Remove cup seat (6).

5 Use brass drift to push pump seal (7) from housing (5). Discard seals.

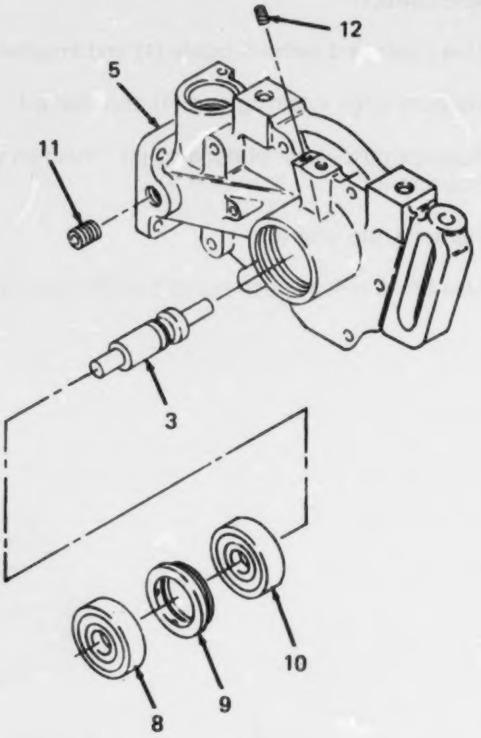


3-26. WATER PUMP ASSEMBLY REPAIR (CONT)

6 Use bearing disassembly fixture to support outer ball bearing (8) and spacer (9). Push shaft (3) from bearing (8) and spacer (9). Discard bearings and spacer.

7 Use bearing disassembly fixture to support bearing (10). Push shaft (3) from bearing (10). Discard bearing and shaft.

8 Remove pipe plugs (11 and 12).



CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all parts with dry cleaning solvent and dry with compressed air.

2 Inspect grooves in pulleys for wear and damage.

3-26. WATER PUMP ASSEMBLY REPAIR (CONT)

3 Inspect water pump housing for cracks, damage, or corrosion. Measure housing bore. Discard housing if bearing bore is larger than 2.45 inches (6.22 mm). Make sure weep hole in housing is open.

NOTE

Repair is limited to the replacement of all kit parts. Damaged or excessive housing clearances will deem water pump nonrepairable and should be replaced with a new assembly.

ASSEMBLY:

1 Apply a light coat of clean lubricating oil to shaft (1).

2 Use fixture ST-658 to support new inner bearing (2).

3 Push pulley end of shaft (1) through bearing until bearing is against larger diameter shoulder of shaft.

4 Use fixture ST-658 to support new outer bearing (3).

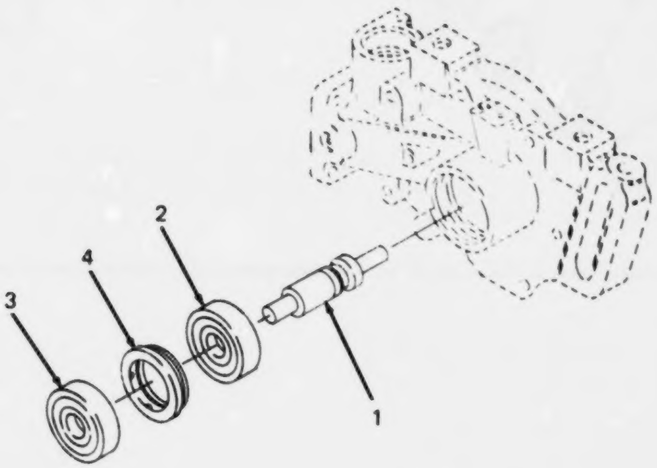
5 Install bearing spacer (4) onto shaft. Push shaft and spacer through bearing until bearing is against spacer.

CAUTION

To prevent damage to the bearing, make sure the inner race of the bearing is not overloaded from contact with the spacer.

NOTE

Insure full rotation of bearings (2 and 3).



3-26. WATER PUMP ASSEMBLY REPAIR (CONT)

6 Apply a thin coat of adhesive sealant to outside diameter of bearings (2 and 3). Install oil seal pilot to impeller end of shaft (1).

7 Install bearing and shaft assembly into bore of housing (5) using fixture ST-658. Remove oil seal pilot.

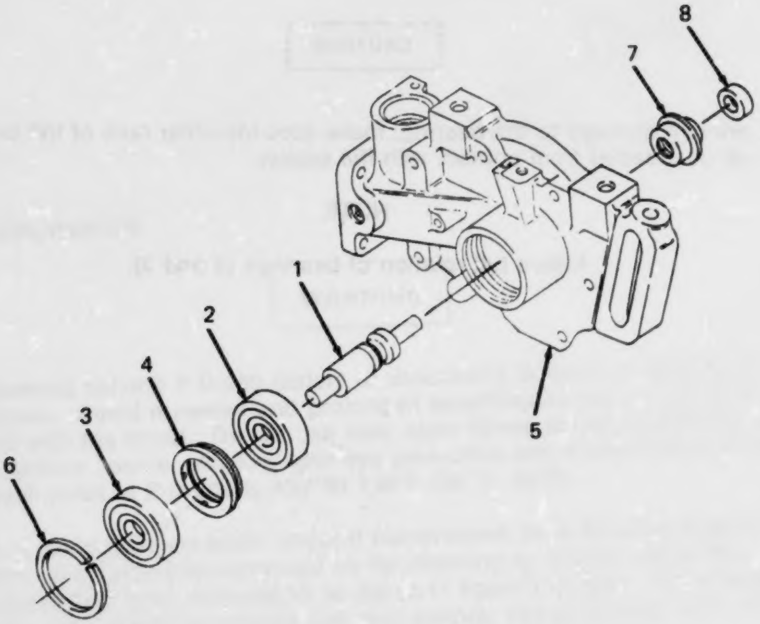
8 Install retaining ring (6), with flat side toward bearing, into groove in housing (5).

9 Turn water pump housing over and support drive side of housing. Apply a coat of adhesive sealant to brass part of pump seal (7) outside diameter. Install pump seal (7) into housing (5) using a mandrel.

CAUTION

Do not apply more than one drop of adhesive sealant. More than one drop will cause the seal and cup seat to become fastened together.

10 Apply one drop of adhesive sealant between shaft and cup seat (8). Install cup seat (8) using a mandrel.



3-26. WATER PUMP ASSEMBLY REPAIR (CONT)

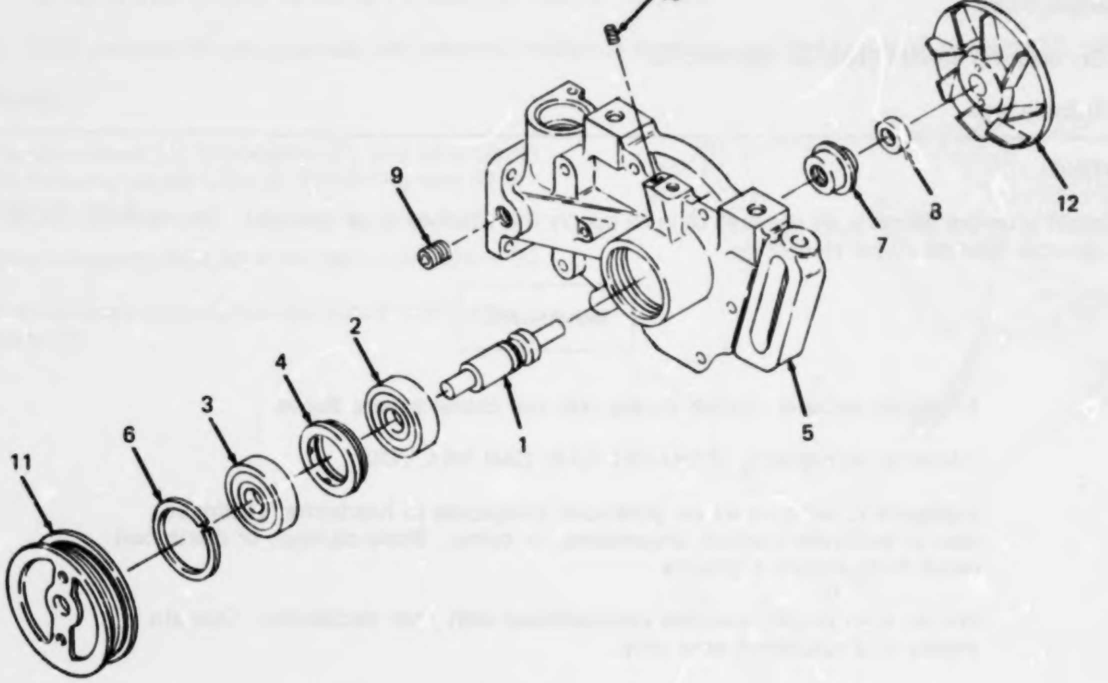
11 Install a clean grease fitting into housing (5). Install grease into housing through fitting until you can see grease through the outer bearing (3).

12 Remove grease fitting from housing. Install pipe plugs (9 and 10).

13 Apply a light coat of adhesive sealant to bore in drive pulley (11). Push water pump shaft into bore until pulley is against larger diameter (shoulder) of shaft.

14 Apply a light coat of adhesive sealant to bore in impeller (12). Support pulley end of shaft. Push impeller onto shaft. Clearance between vanes of cast iron impeller (12) and housing must be 0.020 to 0.040 inch. Clearance for phenolic impeller must be 0.030 to 0.050 inch.

15 Install water pump in accordance with paragraph 2-50.



3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE

This task covers: a. Testing b. Removal c. Cleaning/Inspection/Repair d. Installation

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

Oil pressure gauge (Item 43, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Suitable tags

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area for testing and cleaning

TESTING:

1 Install pressure gauge in oil manifold or in oil supply line attached to oil manifold. The minimum gauge capacity must be 70 psi (485 kPa).

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

2 Start engine in accordance with TM 5-4320-307-10.

3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

3 Operate engine at idle.

4 Bleed gauge line of air.

5 Check gauge reading.

a. If oil pressure is less than 20 psi (138 kPa), the HVT valve is in normal (retarded) mode. Check for voltage at HVT valve. If voltage is present, check for oil leaks at oil connections in rocker housings. If there are no oil leaks, replace valve.

b. If voltage is not present at HVT valve, check fuel pressure switch.

c. If oil pressure is more than 20 psi (138 kPa), the HVT valve is in advanced mode. Remove wire from HVT valve.

d. If oil pressure does not decrease, check resistance across the two terminals of HVT valve. If resistance is not between 28 and 32 ohms, the solenoid must be replaced.

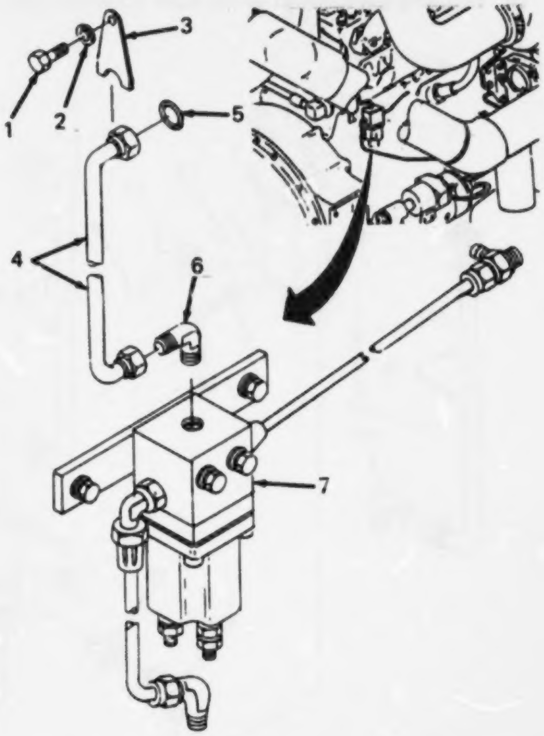
e. If oil pressure did not decrease and solenoid resistance is not as specified in step d, replace HVT valve.

REMOVAL:

1 Remove screw (1), lockwasher (2), and tube clamp (3) securing supply tube (4) and O-ring seal (5) to cylinder head.

2 Remove supply tube (4) from male union elbow (6).

3 Remove male union elbow (6) from shutoff valve body (7).



3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

4 Remove screw (8), washer (9), lockwasher (10), and nut (11) securing clip (12) and supply tube (4) to oil bracket (13).

5 Remove screw (14) and lockwasher (15) securing oil bracket (13) to engine.

6 Remove oil drain tube (16) from check valve (17).

7 Remove check valve (17) and check valve plunger (18) from shutoff valve body (7).

8 Remove oil drain tube (16) from elbow (19).

9 Remove elbow (19).

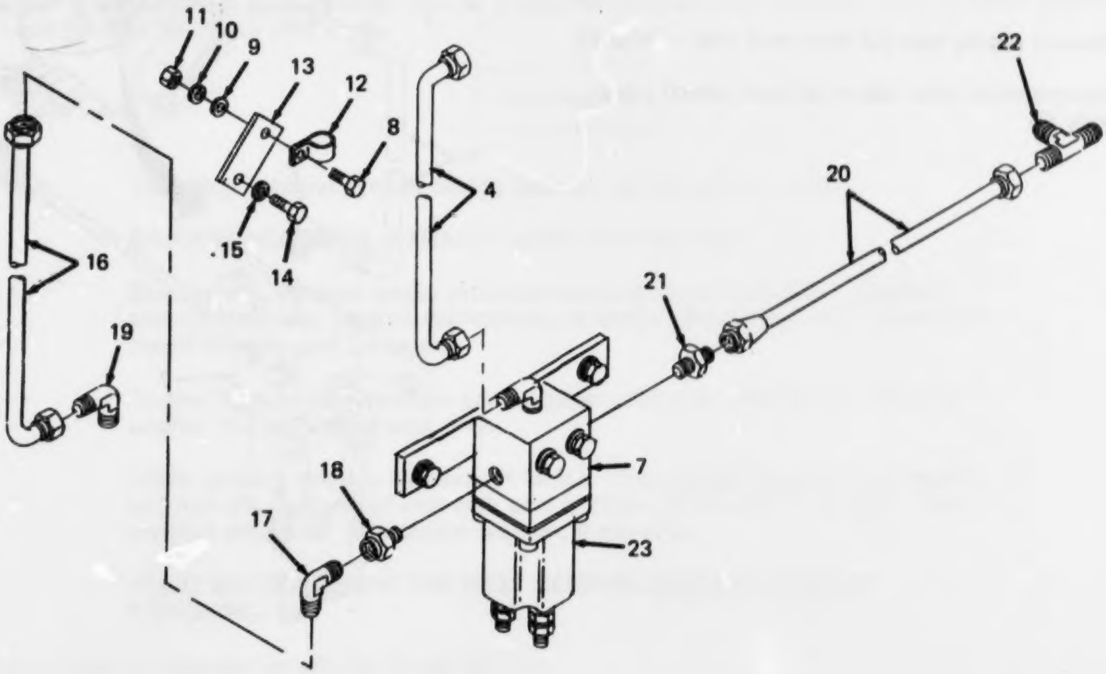
10 Remove tube (20) from male union (21).

11 Remove male union (21).

12 Remove tube (20) from tee (22).

13 Remove tee (22).

14 Tag and disconnect wires from solenoid (23).



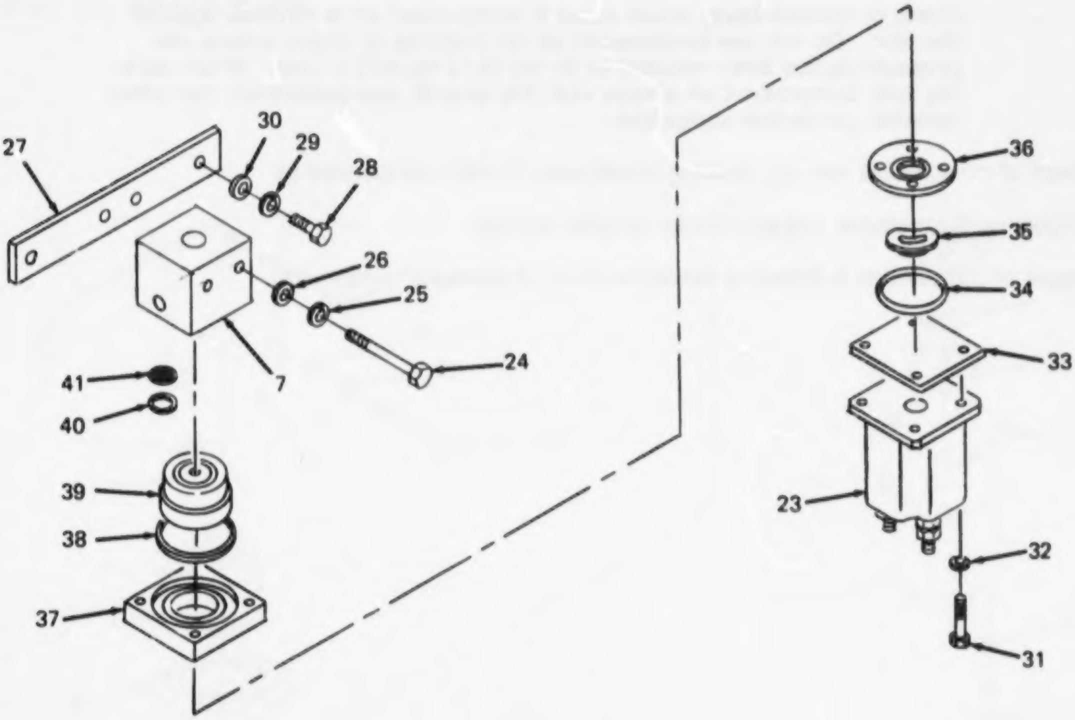
3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

15 Remove two screws (24), lockwashers (25), and washers (26) securing shutoff valve body (7) to shutoff valve bracket (27).

16 Remove two screws (28), lockwashers (29), and washers (30) securing shutoff valve bracket (27) to engine.

17 Remove four screws (31) and lockwashers (32) securing solenoid (23), shutoff shield (33), ring seal (34), valve spring (35), valve disc (36), actuator housing (37), ring seal (38), and actuator disc (39) to shutoff valve body (7).

18 Remove element retainer (40) and filter screen (41).



3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all components with dry cleaning solvent and dry with compressed air.

2 Inspect parts for cracks, striped threads, or other damage.

3 Repair of components is limited to the replacement of damaged components.

3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

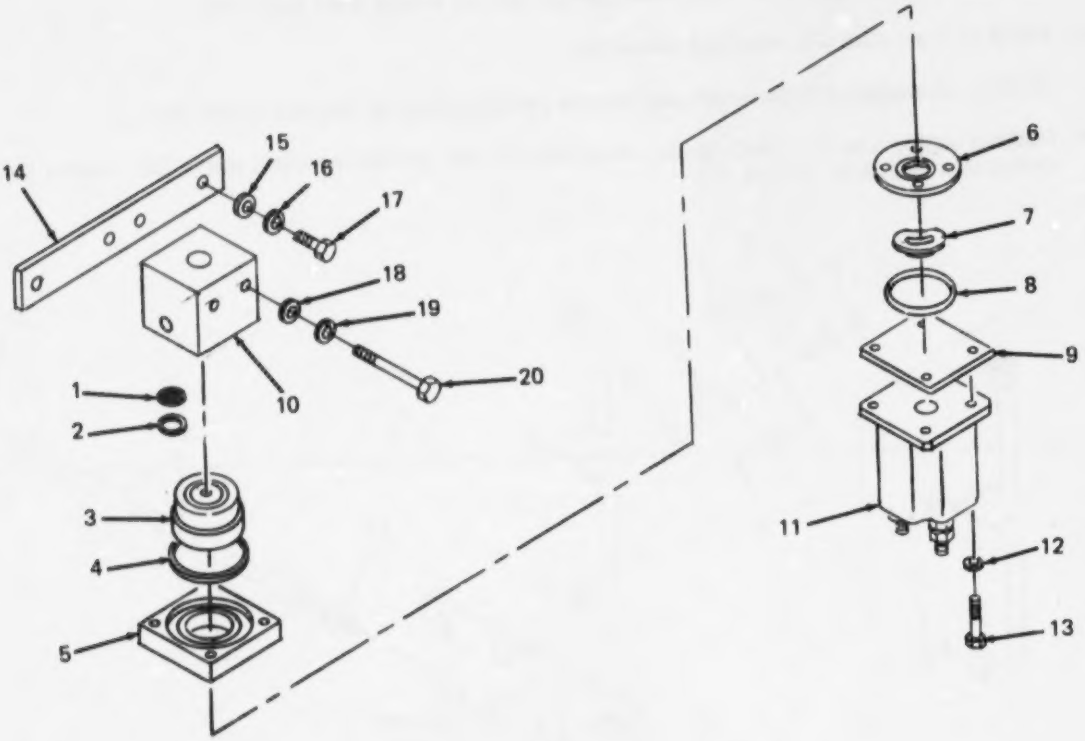
INSTALLATION:

1 Install filter screen (1) and element retainer (2).

2 Position actuator disc (3), ring seal (4), actuator housing (5), valve disc (6), valve spring (7), ring seal (8), and shutoff shield (9) between shutoff valve body (10) and solenoid (11). Secure using four lockwashers (12) and screws (13).

3 Position shutoff valve bracket (14) on engine and secure using two washers (15), lockwashers (16), and screws (17).

4 Position shutoff valve body (10) to shutoff valve bracket (14) and secure using two washers (18), lockwashers (19), and screws (20).



3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

5 Connect wires to solenoid (11). Remove tags.

6 Install tee (21).

7 Install tube (22) on tee (21).

8 Install male union (23).

9 Install tube (22) on male union (23).

10 Install elbow (24).

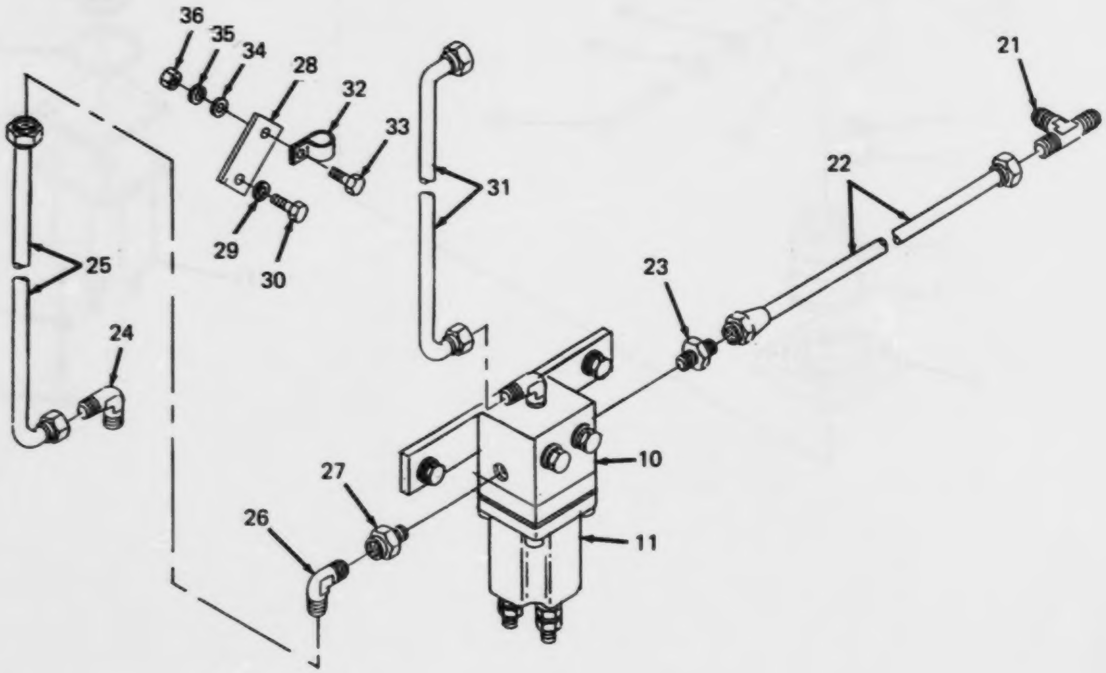
11 Install oil drain tube (25) on elbow (24).

12 Install check valve (26) and check valve plunger (27) on shutoff valve body (10).

13 Install oil drain tube (25) on check valve (26).

14 Position oil bracket (28) on engine and secure using lockwasher (29) and screw (30).

15 Position supply tube (31) and clip (32) on oil bracket (28) and secure using screw (33), washer (34), lockwasher (35), and nut (36).

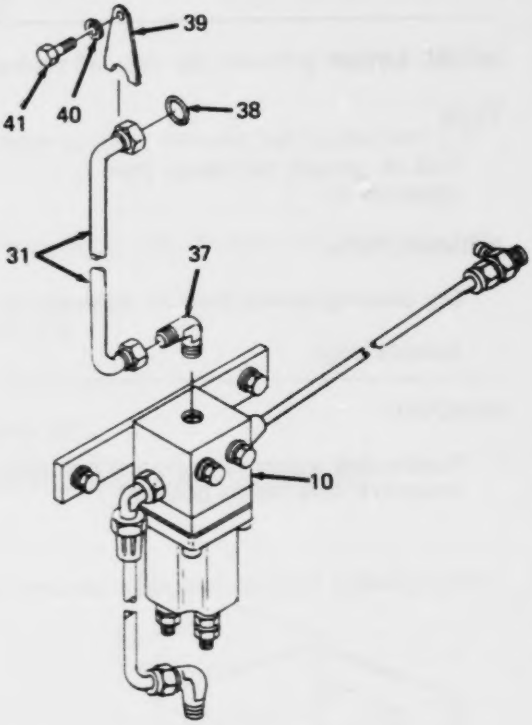


3-27. HVT VALVE ASSEMBLY TEST/REPAIR/REPLACE (CONT)

16 Install male union elbow (37) into shutoff valve body (10).

17 Install supply tube (31) onto male union elbow (37).

18 Position O-ring seal (38) and supply tube (31) on cylinder head and secure using tube clamp (39), lockwasher (40), and screw (41).



3-28. FUEL TUBING REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Suitable plugs

Manual References

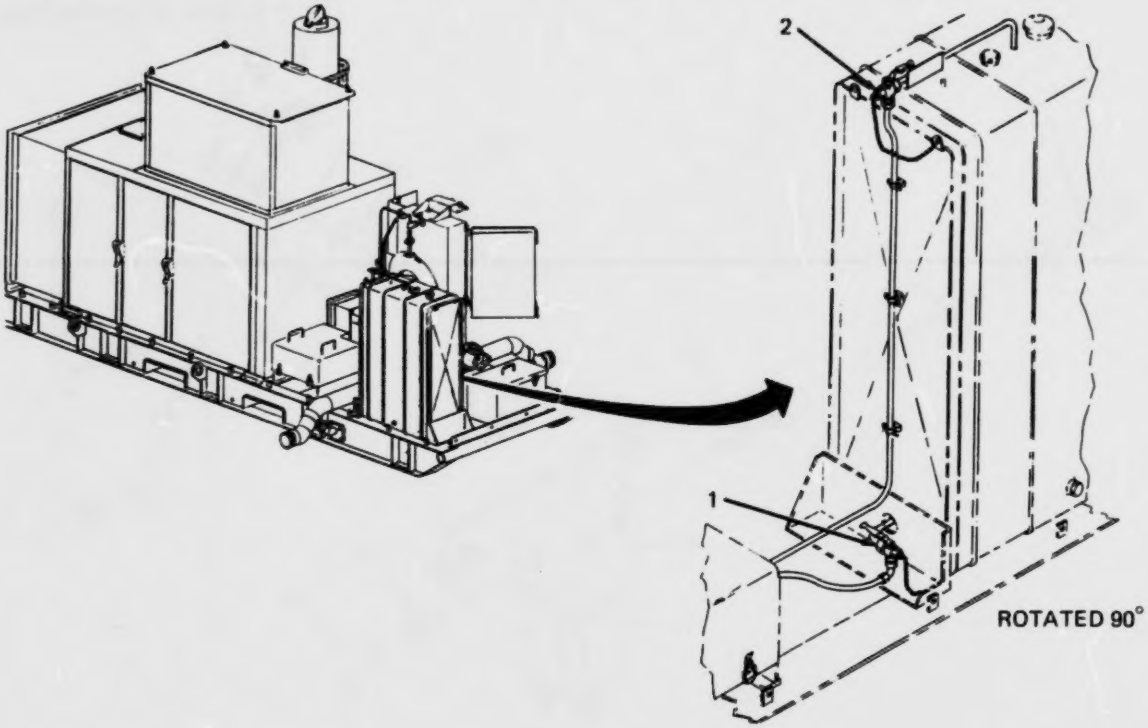
TM 5-4320-307-10

General Safety Instructions

Well ventilated area for cleaning procedures and engine test run

REMOVAL:

1 Position fuel supply valve (1) and fuel return valve (2) to off position, using labels mounted near valves to determine valve handle position.



3-28. FUEL TUBING REPAIR/REPLACE (CONT)

2 Remove tube clamps (3) by unscrewing screw (4) from nut (5).

3 Unscrew two screws (6) and remove lockwashers (7), plain washers (8), clips (9), mounting spacers (10), clips (11), and mounting spacers (12).

4 Unscrew tubing nut (13) from elbow (14), and tubing nut (15) from tee (16). Remove fuel supply tube (17).

5 Unscrew tubing nut (18) from tee (19).

6 Unscrew tubing nut (20) from elbow (21), and tubing nut (22) from elbow (23). Remove fuel drain tube (24), tee (19), and fuel bypass tube (25).

7 Remove fuel drain tube (24) and fuel bypass tube (25) from tee (19).

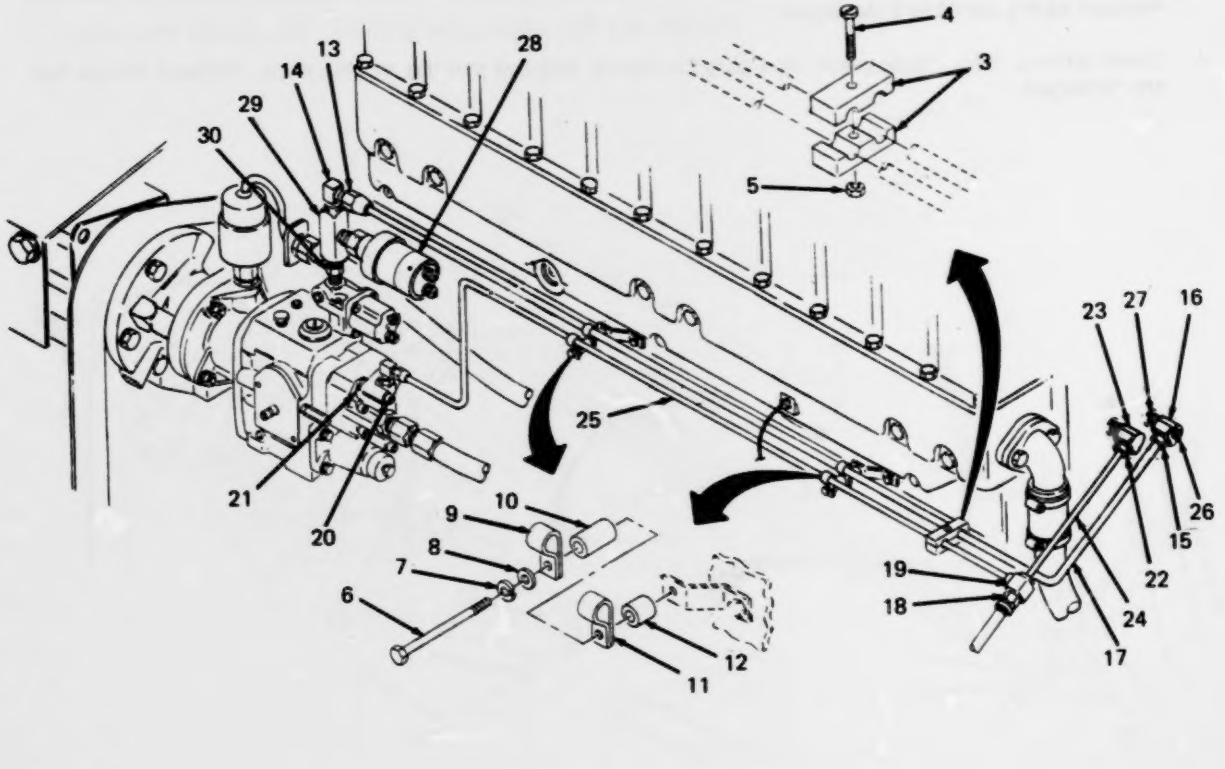
8 Unscrew and remove elbows (14, 21, and 23).

9 Remove pipe plug (26) from tee (16) and remove tee with nipple (27).

10 Tag and disconnect wiring from pressure switch (28) and remove pressure switch from tee (29).

11 Remove tee (29) with nipple (30).

12 Plug four connection points where elbows and tee have been removed to prevent dirt from entering system.



3-28. FUEL TUBING REPAIR/REPLACE (CONT)

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean fuel tubing and all fittings internally by blowing through with compressed air. After cleaning, plug tubing ends to prevent dirt entering.

2 Clean outside of fuel tubing, elbows, tees, nipples, and pipe plug with dry cleaning solvent. Dry with compressed air.

3 Inspect tubing for cracks or other damage and check tubing nuts for cracks, stripped threads, or distortion. Replace tubing sections if damaged.

4 Check elbows, tees, nipples, and pipe plug for cracks, stripped threads, or distortion. Replace fittings that are damaged.

3-28. FUEL TUBING REPAIR/REPLACE (CONT)

INSTALLATION:

1 Remove plugs used to prevent dirt entry.

2 Install nipple (1) and tee (2).

3 Install pressure switch (3) to tee (2) and connect wires to pressure switch.

4 Install elbows (4, 5, and 6) and tee (7) with nipple (8).

5 Install pipe plug (9) to tee (7).

6 Connect fuel drain tube (10) and fuel bypass tube (11) to tee (12).

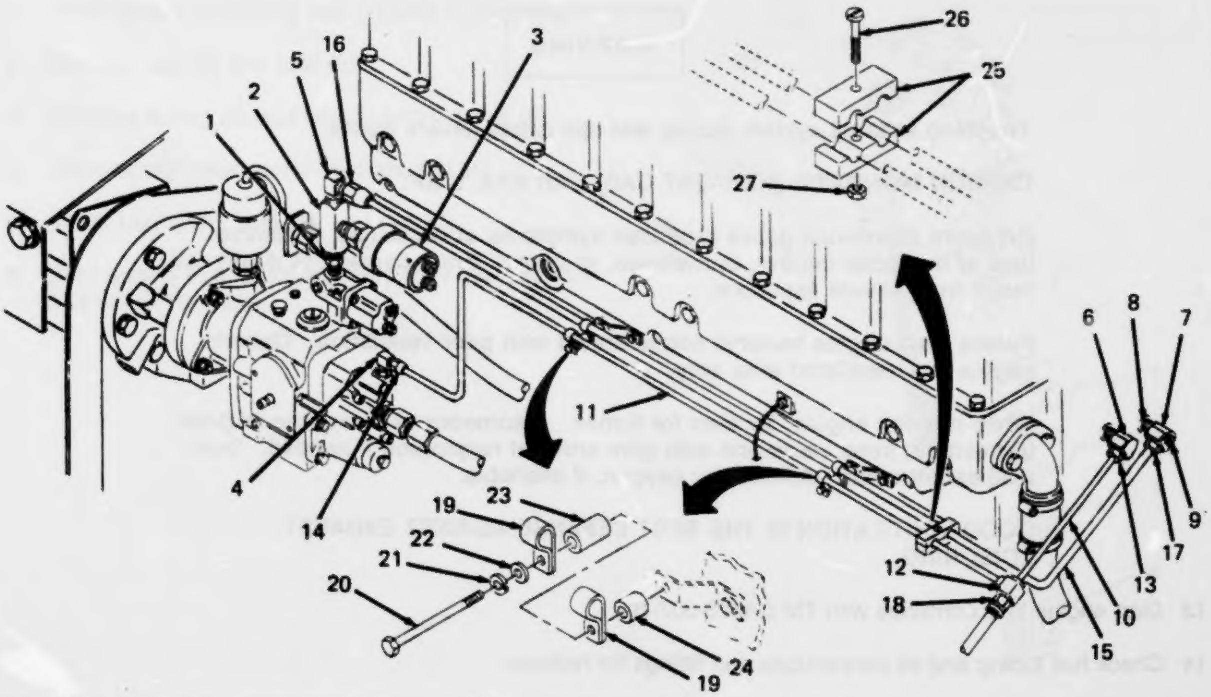
7 Install fuel drain tube (10) and fuel bypass tube (11) to engine by connecting tubing nut (13) to elbow (6), and tubing nut (14) to elbow (4).

8 Install fuel supply tube (15) to engine by connecting tubing nut (16) to elbow (5), and tubing nut (17) to tee (7).

9 Connect tubing nut (18) to tee (12).

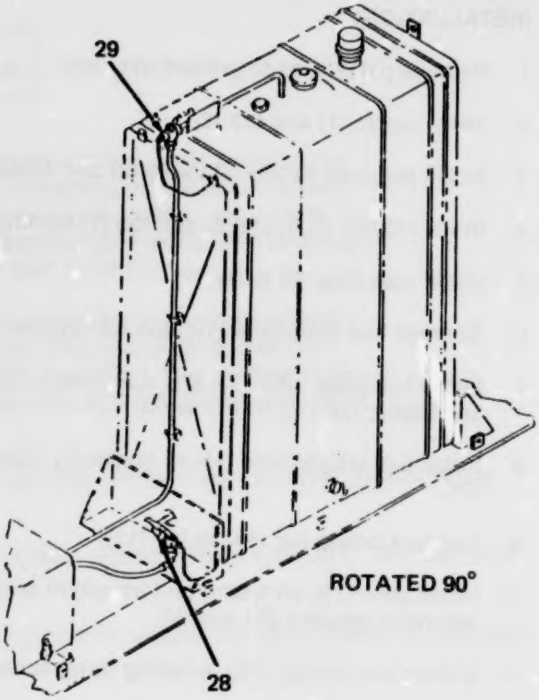
10 Install clips (19) on tubing and secure to engine with screws (20), lockwashers (21), plain washers (22) and mounting spacers (23 and 24).

11 Install tube clamps (25) to tubing using screw (26) and nut (27).



3-28. FUEL TUBING REPAIR/REPLACE (CONT)

12 Position fuel supply valve (28) and fuel return valve (29) to unit tank position.



WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

13 Start engine in accordance with TM 5-4320-307-10.

14 Check fuel tubing and all connections and fittings for leakage.

3-29. FUEL PUMP ASSEMBLY SERVICE/TEST/REPLACE

This task covers: a. Servicing b. Testing c. Removal d. Cleaning/Inspection e. Installation f. Operational Check

INITIAL SETUP

Test Equipment

Multimeter (Item 12, Appendix B)

DC power supply (Item 16, Appendix B)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Fuel screen and magnet

Rag

Gasket

Suitable tags

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area for operational check

SERVICING:

1 Clean area surrounding cap (1) with a clean rag.

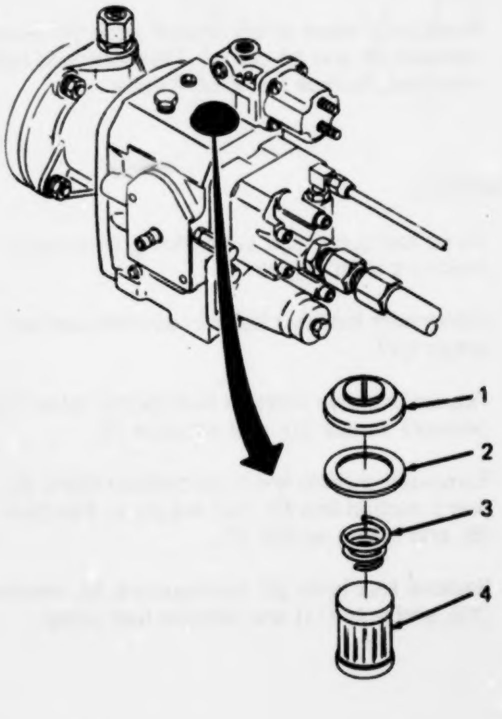
2 Remove cap (1) and seal (2).

3 Remove spring (3) and screen and magnet (4).

4 Replace with new screen and magnet (4).

5 Install spring (3), seal (2), and cap (1).

6 Start engine in accordance with TM 5-4320-307-10 and check for leaks.

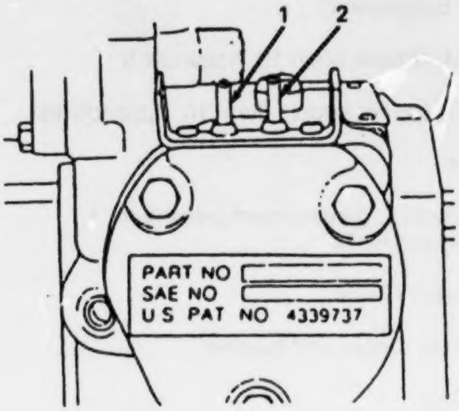


3-29. FUEL PUMP ASSEMBLY SERVICE/TEST/REPLACE (CONT)

TESTING:

NOTE

The actuator is located between fuel shutoff valve and engine block.



1 Apply 24 Vdc across the two terminals (1 and 2) on actuator.

NOTE

The actuator will make a loud click when the actuator shaft hits the internal stop.

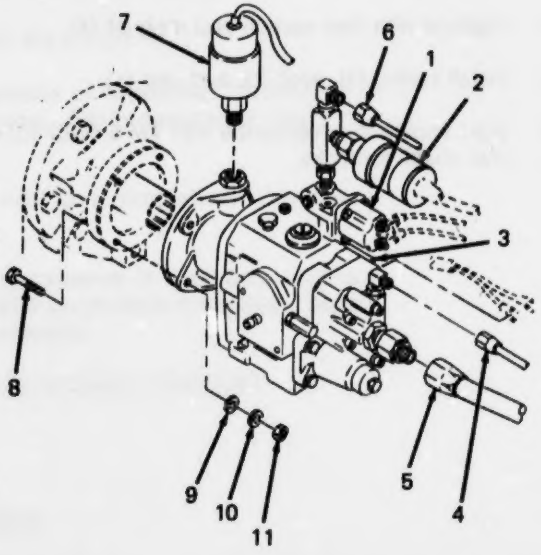
2 Remove voltage from actuator terminals. This allows the force of the springs to return actuator shaft to its original position.

NOTE

A click must be heard when the voltage is removed. If the actuator does not click as if it is not operating or operating slow, notify general support maintenance.

3 Resistance value of fuel shutoff valve (1) should be between 28 and 32 ohms. If resistance is not as indicated, replace fuel shutoff valve.

REMOVAL:



1 Clean fuel pump and surrounding area before removing it from engine.

2 Disconnect battery cables in accordance with paragraph 2-27.

3 Tag and remove wires to fuel shutoff valve (1), fuel pressure sensor (2), and actuator (3).

4 Remove fuel drain line from cylinder head (4), gear pump suction line (5), fuel supply to injectors line (6), and speed sensor (7).

5 Remove four bolts (8), lockwashers (9), washers (10), and nuts (11) and remove fuel pump.

3-29. FUEL PUMP ASSEMBLY SERVICE/TEST/REPLACE (CONT)

CLEANING/INSPECTION:

1 Clean gasket surface of fuel pump and accessory drive.

2 Inspect fuel pump for cracks and evidence of leakage. If further maintenance is required, notify general support maintenance.

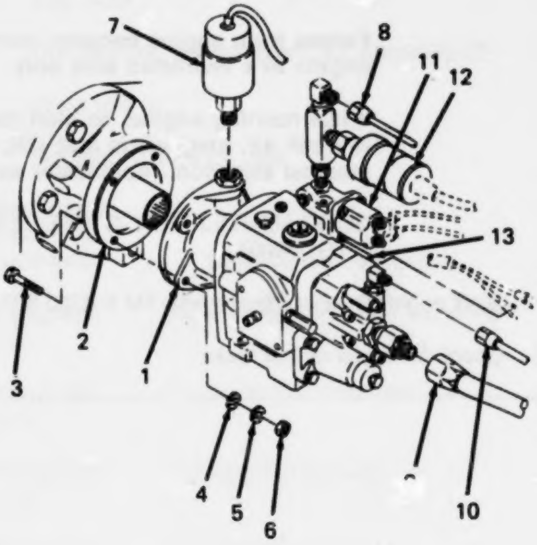
INSTALLATION:

1 Position fuel pump (1) with new gasket on accessory drive (2) and secure using four bolts (3), lockwashers (4), washers (5), and nuts (6).

2 Install speed sensor (7), fuel supply to injector line (8), gear pump suction line (9), and fuel drain line from cylinder head (10).

3 Connect wires to fuel shutoff valve (11), fuel pressure sensor (12), and actuator (13). Remove tags.

4 Connect battery cables in accordance with paragraph 2-27.



3-29. FUEL PUMP ASSEMBLY SERVICE/TEST/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

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While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Check for signs of fuel leaks.

3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection/Repair d. Assembly e. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Arbor press

Pulley installation tool

Slide hammer (Item 2, Appendix B)

Fuel pump drive oil seal mandrel (Item 30, Appendix B)

Inside micrometer, 1 - 2 inch (Item 4, Appendix B)

Outside micrometer, 1 - 2 inch (Item 36, Appendix B)

Suitable magnet

Materials/Parts

Grease (Item 13, Appendix C)

Antiseize tape (Item 31, Appendix C)

Emery cloth (Item 2, Appendix C)

Materials/Parts (Cont)

Crocus abrasive cloth (Item 1, Appendix C)

Grease (Item 16, Appendix C)

Soft cloth

Dry cleaning solvent (Item 30, Appendix C)

Wear sleeve

Accessory drive oil seal

Equipment Condition Reference	Condition Description
Paragraph 2-41	Water pump drive belt removed
Paragraph 2-41	Fan drive belt removed
Paragraph 2-35	Fan guard removed
Paragraph 3-29	Fuel pump removed

REMOVAL:

1 Rotate crankshaft until the A mark (1) on accessory drive pulley (2) is aligned with pointer (3) on gear cover.

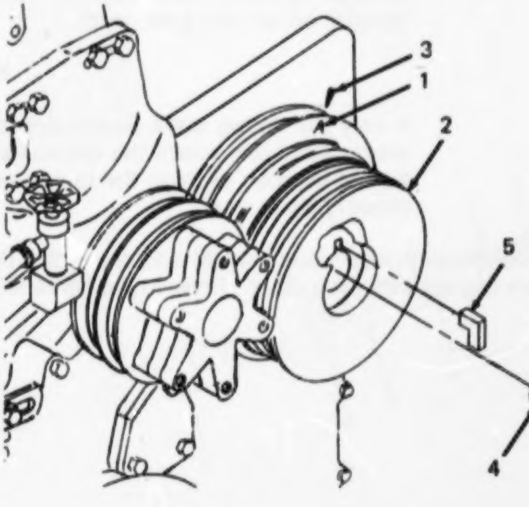
2 Remove nut (4) and key (5).

3 Use standard wheel puller to remove accessory drive pulley (2).

CAUTION

Copper jaws must be used in the vise to prevent damage to the pulley.

4 Put accessory drive pulley (2) into vise.



3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

CAUTION

Take caution not to damage surface of wear sleeve with chisel.

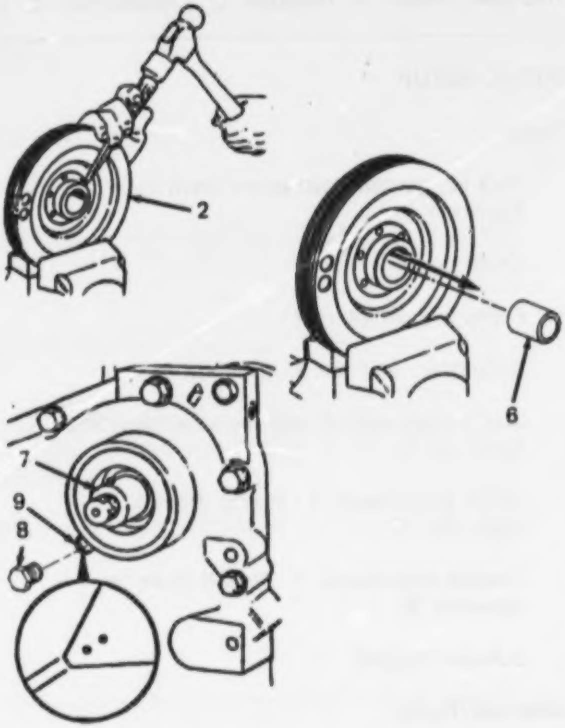
5 Put chisel against wear sleeve (6). Use moderate blows with hammer to strike chisel at four points on outside diameter of wear sleeve to relieve press fit.

6 When press fit has been relieved, remove wear sleeve (6) from accessory drive pulley (2).

7 Remove accessory drive seal (7) in accordance with paragraph 3-39.

8 Use magnet and clean cloth to remove any metal particles from seal area.

9 Remove pipe plug (8) from inspection hole (9) in gear cover.



CAUTION

The timing marks on the accessory drive gear and the camshaft gear must be aligned when the A mark on the accessory drive pulley and aligns with the pointer on the gear cover.

NOTE

If only the timing mark on the accessory drive gear is visible through the inspection hole, rotate the crankshaft one complete revolution in the direction of rotation to align the timing marks on the camshaft gear and the accessory drive gear.

10 Look through inspection hole (9) and check that timing marks on camshaft gear and accessory drive gear are aligned with each other. Refer to the figure for details of alignment marks.

3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

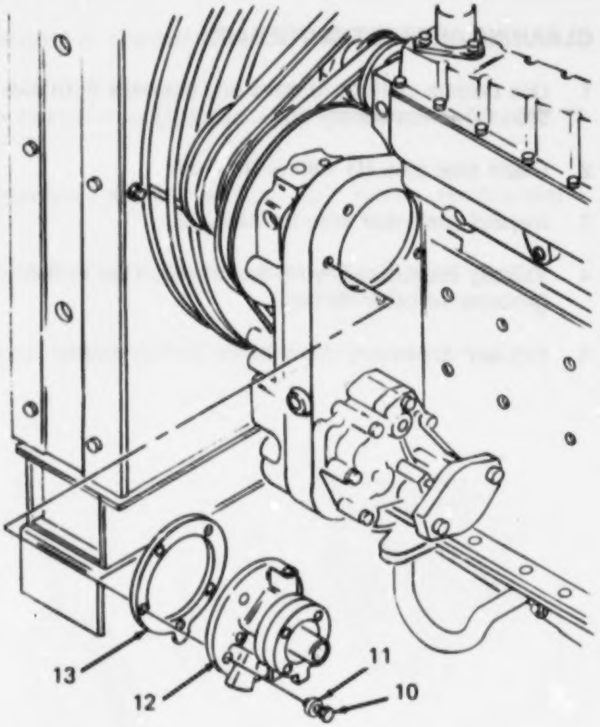
CAUTION

If the accessory drive dowel pin has been incorrectly installed, the dowel pin must be removed before attempting to remove the accessory drive to prevent damage to the accessory drive bushing.

11 Remove five capscrews (10) with captive washers (11).

12 Remove accessory drive housing (12) with gasket (13).

13 Clean cylinder block and accessory drive housing gasket surfaces.



DISASSEMBLY:

1 Remove capscrew (1) and washer (2) from shaft (3). Install capscrew into shaft after removing washer.

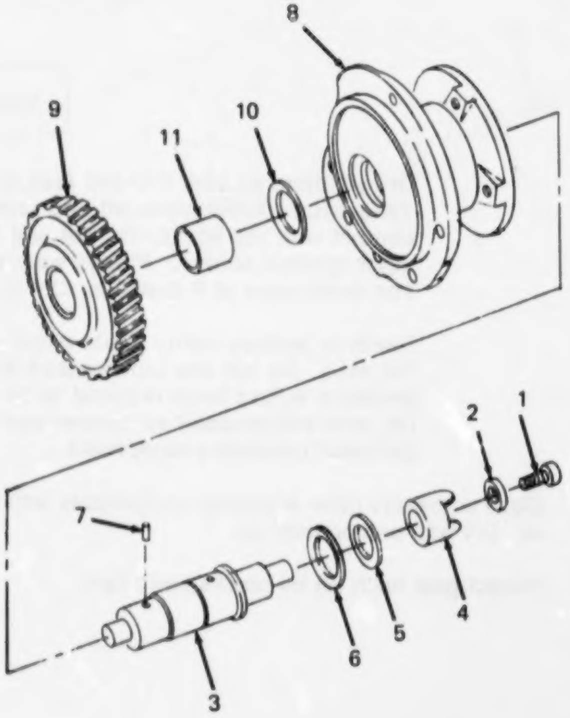
2 Remove coupling (4) using coupling puller.

3 Remove washer (5) and thrust bearing (6).

4 Remove pulley dowel pin (7) from shaft (3).

5 Place accessory drive housing (8) on a support and press shaft (3) out of gear (9).

6 Remove gear (9) and thrust bearing (10) and bushing (11).



3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

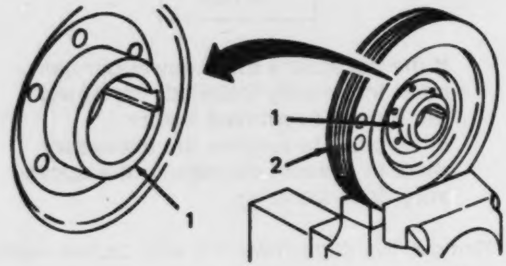
1 Use crocus cloth to remove any deposits from seal area (1) of accessory drive pulley (2).

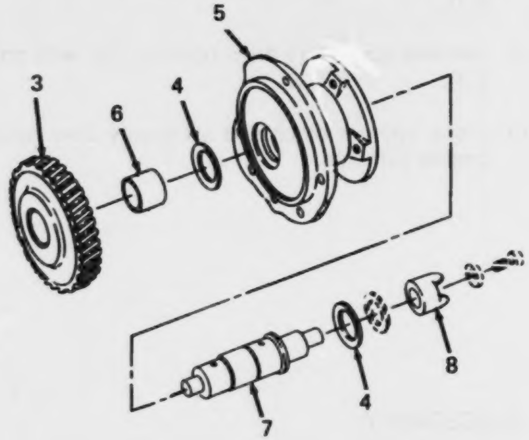
2 Clean seal area (1) with clean cloth.

3 Inspect seal wear area for damage.

4 Visually inspect pulley (2) for cracks, wear in belt grooves, or other damage.

5 Replace accessory drive pulley (2) if damaged.





WARNING

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Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

6 Clean accessory drive assembly components with dry cleaning solvent to remove all traces of grease and oil. Dry with compressed air.

7 Inspect gear teeth (3) for cracks and chips.

3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

8 Inspect thrust bearings (4) for freedom of movement, scored or cracked races, or worn rollers. If any part of bearing is damaged, replace bearing.

9 Inspect accessory drive housing (5) for cracks. Check inside housing for damage due to bearings having turned in housing. Replace housing if damaged.

10 Check bushing (6) in housing (5). If bushing inside diameter is worn larger than 1.321 inches, remove and discard bushing.

11 Check shaft (7) for wear, distortion, or damage. Outside diameter of shaft must not be less than 1.310 inches.

12 Inspect coupling (8) for broken or chipped teeth. Replace coupling if damaged.

ASSEMBLY:

1 If bushing (1) was removed, press a new bushing into housing (2).

2 Apply a coat of lubricating oil to inside of bushing (1).

3 Insert shaft (3) through bushing (1) and through housing (2).

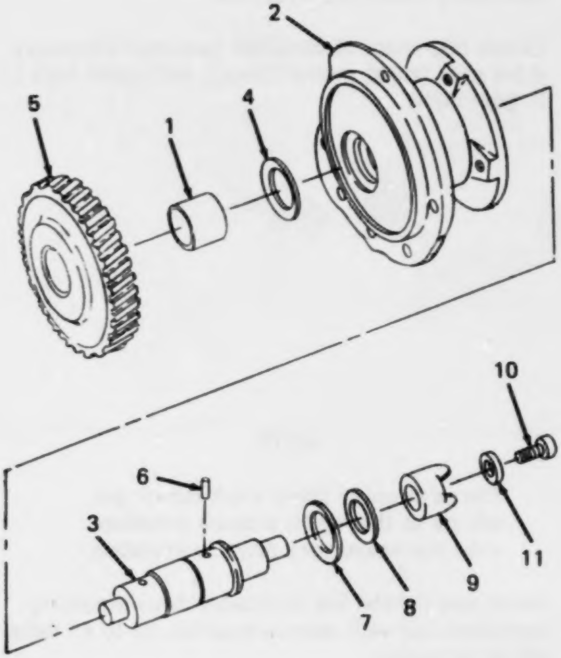
4 Install thrust bearing (4) to shaft (3). Lubricate thrust bearing with grease.

5 Align keyway in gear (5) with key (6) in shaft and press gear onto shaft.

6 Install thrust bearing (7) and washer (8) on shaft (3). Lubricate thrust bearing with grease.

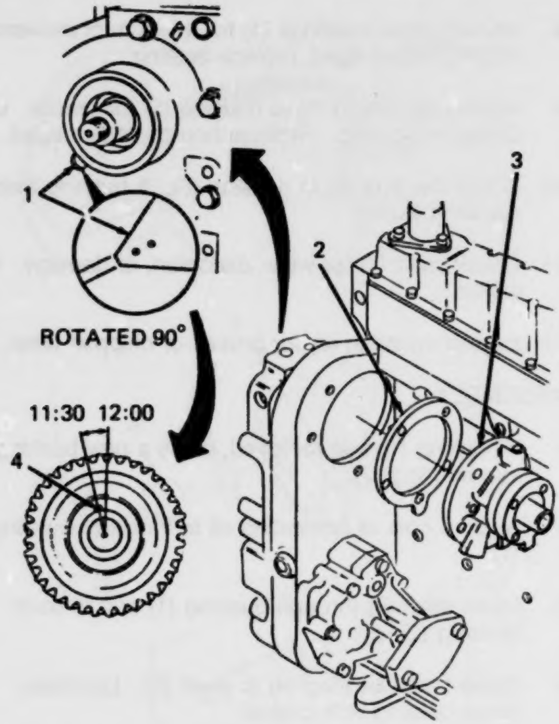
7 Press coupling (9) onto shaft (3).

8 Install capscrew (10) with washer (11) into end of shaft (3).



3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

INSTALLATION:



1 If crankshaft was rotated after accessory drive was removed, rotate crankshaft until timing mark on camshaft gear is visible in inspection hole (1) before installing accessory drive assembly.

2 Install new gasket (2) on accessory drive assembly (3).

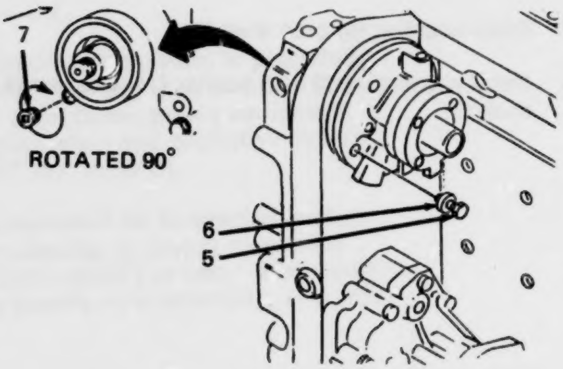
3 Put accessory drive shaft dowel pin (4) at approximately 11:30 o'clock position when facing shaft from pulley end.

4 Install accessory drive assembly (3) in gear housing accessory drive mounting hole.

5 Check alignment of camshaft gear and accessory drive gear timing marks through inspection hole (1) in gear cover.

NOTE

The accessory drive shaft dowel pin will be at the 12:00 o'clock position after the accessory drive is installed.



6 Install and tighten five accessory drive mounting capscrews (5) with captive washers (6) to 45 ft-lbs (60 N•m) torque.

7 Apply antiseize tape to 3/8-inch inspection hole pipe plug (7).

8 Install and tighten plug (7) to 20 ft-lbs (30 N•m) torque.

3-30. ACCESSORY DRIVE ASSEMBLY REPAIR/REPLACE (CONT)

9 Install new accessory drive seal (8) in gear cover. Refer to paragraph 3-42.

10 Install dowel pin (9) in shaft (10).

11 Apply a film of grease or equivalent to shaft (10).

12 Align keyway in pulley (11) with dowel pin (9) in shaft (10).

13 Use your hand to partially push pulley (11) on shaft (10).

14 Install pulley installation tool (12) on shaft (10) and press pulley on shaft until it fits against gear.

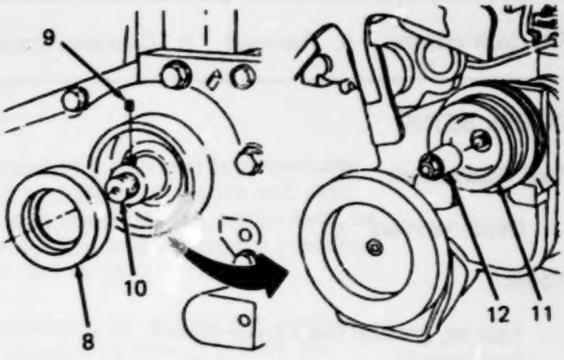
15 Install keyway seal (13) in pulley (11) keyway.

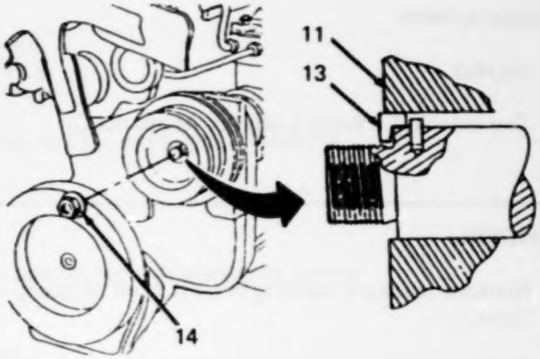
16 Install nut (14) on shaft (10) and tighten nut to 310 ft-lbs (420 N•m) torque.

17 Install fuel pump in accordance with paragraph 3-29.

18 Install fan drive belt and water pump drive belts in accordance with paragraph 2-41.

19 Install fan guard in accordance with paragraph 2-35.





3-31. LUBRICATING OIL PUMP INSPECT/REPLACE

This task covers: a. Removal b. Cleaning/Inspection c. Installation d. Operational Check

INITIAL SETUP

Test Equipment

Depth verniers

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Gasket

Dry cleaning solvent (Item 30, Appendix C)

Manual References

TM 5-4320-307-10

General Safety Instructions

Well ventilated area

Equipment Condition Reference	Condition Description
Paragraph 2-36	Oil drained
Paragraph 3-38	Oil transfer tube removed

REMOVAL:

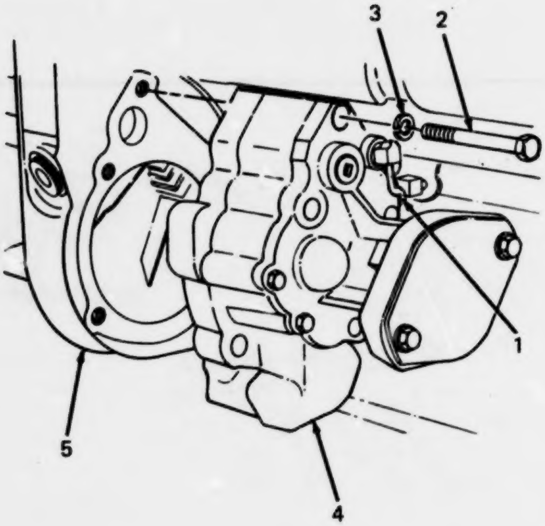
1 Remove pressure sensing line (1) from oil pump and block.

2 Remove five capscrews (2) and lockwashers (3) that hold lubricating oil pump (4) to gear case (5).

CAUTION

Do not pry on the lubricating oil pump mounting flange.

3 Remove lubricating oil pump (4) from gear case (5). Discard gasket.



3-31. LUBRICATING OIL PUMP INSPECT/REPLACE (CONT)

CLEANING/INSPECTION:

WARNING

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Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

CAUTION

Do not allow dirt or gasket material to enter the oil passages. Bearing damage can result.

NOTE

For cleaning purposes, the cover and the gasket for the hydraulic pump mounting flange must be removed.

1 Clean lubricating oil pump and gear case gasket surfaces.

2 Use dry cleaning solvent to clean lubricating oil pump and dry with compressed air.

3 Inspect gears for freedom of rotation.

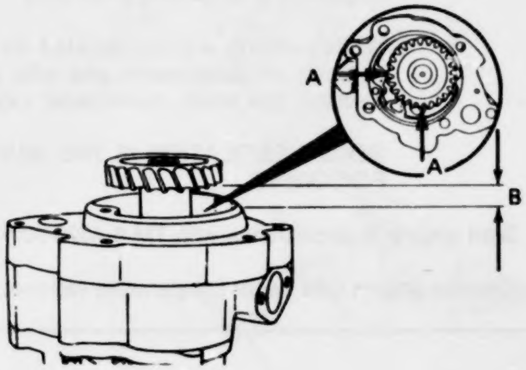
4 Inspect gears for cracked or broken teeth.

5 Inspect bushings for excessive wear or discoloration due to overheating or seizure to shafts.

6 Using depth verniers measure drive shaft end clearance in two locations 90 degrees apart (A).

Drive Shaft End Clearance (B)

mm		in.
0.05	MIN	0.002
0.13	MAX	0.005



3-31. LUBRICATING OIL PUMP INSPECT/REPLACE (CONT)

NOTE

If drive shaft end clearance is not within specifications or further maintenance of the lubricating oil pump is required, contact general support maintenance.

INSTALLATION:

1 Install lube oil pump mounting flange gasket and cover. Tighten capscrews to 20 ft-lbs (25 N m) torque.

2 Install new gasket on body of lubricating oil pump.

3 Install lubricating oil pump in mounting hole in cylinder block flange.

4 Install five mounting capscrews and lockwashers. Tighten capscrews to 40 ft-lbs (55 N·m) torque.

5 Install lubricating oil transfer tube using capscrews.

6 Install pressure sensing line and tighten nuts to 120 in-lbs (15 N·m) torque.

7 Install oil transfer tube in accordance with paragraph 3-38.

8 Fill engine oil in accordance with paragraph 2-36.

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Operate engine until water temperature reaches 180°F (80°C). Check oil pressure and check for oil leaks.

3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR

This task covers: a. Disassembly b. Cleaning c. Inspection d. Testing e. Repair f. Assembly

INITIAL SETUP

Test Equipment

Oil cooler core pressure test kit, P/N 3376765 (Item 27, Appendix B)

Regulated air pressure line

Test plate, P/N 3376768 (Item 35, Appendix B)

Suitable tank (water)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Oil cooler maintenance kit, P/N 3801199

Carbon tetrachloride (Item 8, Appendix C)

Materials/Parts

Vegetable oil (Item 33, Appendix C)

Sodium carbonate (Item 28, Appendix C)

Dry cleaning solvent (Item 30, Appendix C)

O-ring

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-52	Lube oil cooler removed

General Safety Instructions

Well ventilated area

DISASSEMBLY:

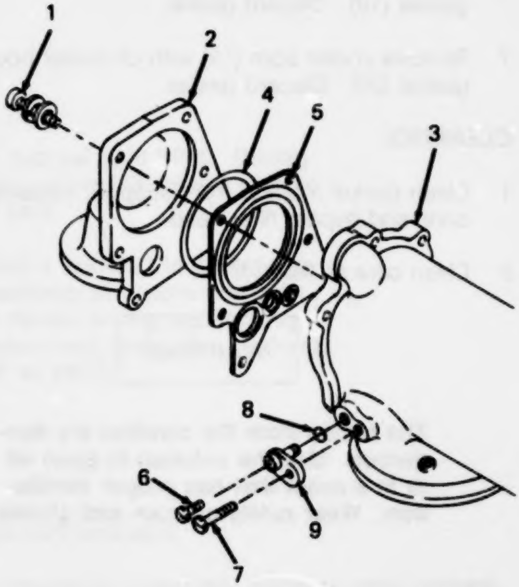
CAUTION

Do not reuse an oil cooler core after an engine failure. Do not allow dirt or gasket material to enter the oil passages when cleaning the oil cooler and cylinder block surface.

1 Remove six capscrews, lockwashers, and washers (1) that hold bypass filter head (2) to cooler housing (3).

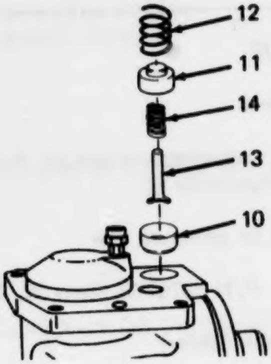
2 Remove and discard rectangular ring seal (4) and oil cooler cover gasket (5).

3 Remove capscrew and washer (6), capscrew (7), O-ring seal (8), and sending unit (9) from cooler housing (3). Discard O-ring seal.



3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

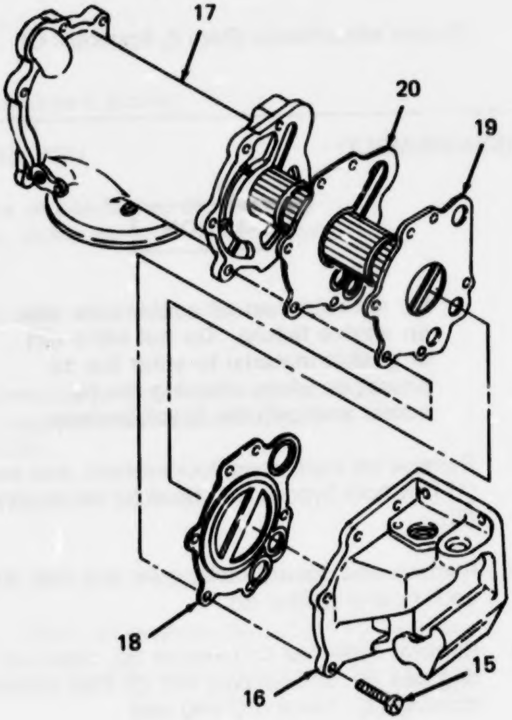
4 Remove oil cooler bypass valve (10) and pressure sensing valves (11), with compression spring (12), bypass valve plunger (13) and compression cover spring (14).



5 Remove six capscrews (15) that hold oil cooler support (16) to oil cooler housing (17).

6 Remove oil cooler support (16) with oil cooler core gasket (18). Discard gasket.

7 Remove cooler core (19) with oil cooler housing gasket (20). Discard gasket.



CLEANING:

1 Clean gasket material from support, housing, cooler core, and bypass filter head.

2 Clean core as follows:

WARNING

The fumes from the solution are dangerous. Use the solution in open air or in a room that has proper ventilation. Wear safety glasses and gloves.

3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

WARNING

Carbon tetrachloride is highly toxic. Do not breathe vapors. Use only in a well ventilated area. To avoid death or injury, use protective clothing.

a. Place core into a container of carbon tetrachloride. Keep element in solution for several minutes. Then, flush solution around and through tubes in element.

WARNING

Alkaline is highly toxic. Do not breathe vapors. To avoid death or injury, use protective clothing. Use only in a well ventilated area.

b. Flush tubes with a solution of alkaline. After cleaning, flush several times with hot water.

WARNING

Muriatic acid is toxic. It burns skin on contact. To avoid death or injury, keep acid off skin, eyes, and clothes. Wear protective clothing.

c. Put core into a container of 1 part muriatic acid, 9 parts water, and 1 lb (0.5 kg) oxalic acid and 0.01 gallon of pyridene added to each 5 gallons (18.9 liters) of muriatic acid.

d. Remove core when there are no foam or bubbles in solution. Foam and bubbles normally stop in 30 to 60 seconds.

e. Put element into a container that has a 5 percent solution of sodium carbonate. Remove element when there are no bubbles coming from solution.

f. Flush core with clean warm water.

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

3 Clean the housing using steam and dry cleaning solvent.

INSPECTION:

1 Check cooler housing, support, and cover for cracks, damage, and corrosion.

2 Check core for plugged or damaged tubes. Inspect sealing surfaces for scratches, dents, or other damage.

3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

TESTING:

1 Install oil cooler core in oil cooler pressure test kit.

2 Attach a regulated air pressure line to Test Plate, and apply 60 psi (415 kPa) air pressure.

3 Install oil cooler in a tank of water and inspect for leaks.

NOTE

If leaks are found, replace the oil cooler core.

4 Remove oil cooler core from water tank.

5 Remove pressure test equipment.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

6 Dry oil cooler with compressed air.

REPAIR:

CAUTION

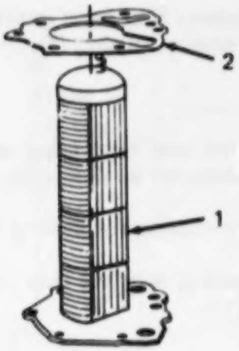
Do not attempt to repair a damaged oil cooler core; it must be replaced.

1 If oil cooler core leaks or is damaged, it must be replaced.

2 Repair of remaining parts is limited to replacement.

3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

ASSEMBLY:



1 Put oil cooler core (1) in an upright position with large portion of flange down.

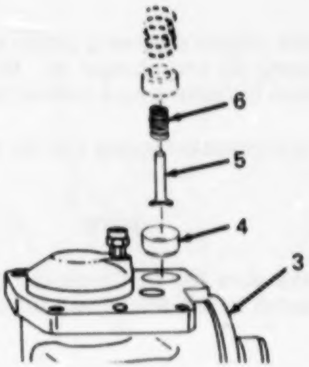
2 Install a new gasket (2) over core (1). Align holes in gasket with holes in core.

3 Assemble housing (3) over core (1). Align holes in housing with holes in core.

4 Lubricate bypass piston (4) and install it in housing (3) with open end on top.

5 Install bypass valve plunger (5) in piston (4).

6 Install spring (6) over plunger (5) into piston (4).

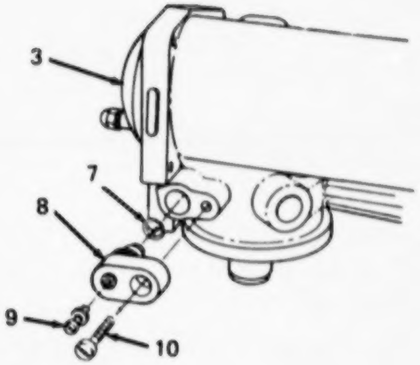


CAUTION

The sending unit must be installed before the pressure sensing piston to prevent damage to the piston.

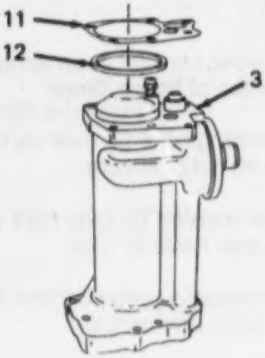
7 Insert O-ring seal (7) and install sending unit (8) into housing (3).

8 Install capscrew and washer (9) and capscrew (10) and tighten to 120 in-lbs (15 N•m) torque.



3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

9 Install bypass filter head gasket (11) over end of lube oil cooler housing (3).



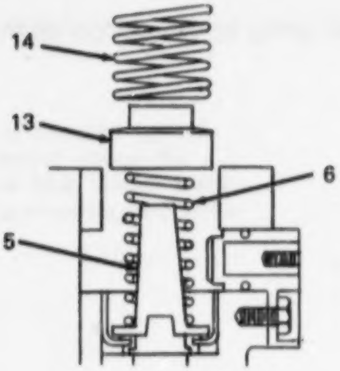
NOTE

Do not use lubricating oil on the rectangular sealing ring.

10 Lubricate rectangular sealing ring (12) with lube oil.

11 Install sealing ring (12) over cooler core and against gasket (11).

12 Lubricate pressure sensing piston (13) and install it over spring (6) and plunger (5). Move piston up and down to make sure it moves freely in bore.



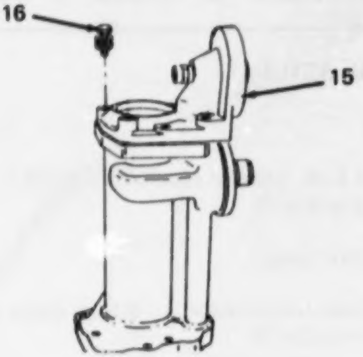
13 Install compression spring (14) on top of piston (13).

NOTE

Make sure the compression spring is located in the filter head bore.

3-32. LUBE OIL COOLER ASSEMBLY INSPECT/TEST/REPAIR (CONT)

14 Install bypass filter head (15) over end of cooler element.

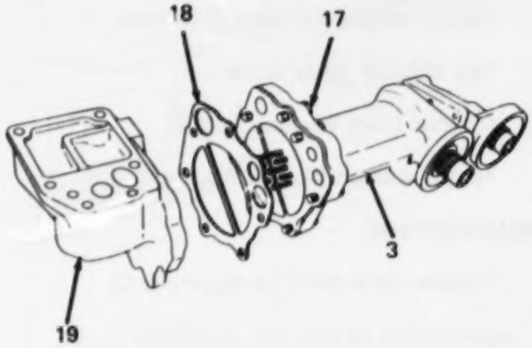


15 Move filter head assembly (15) up and down to make sure pressure sensing piston moves freely in housing bore.

16 Use your hand to press filter head (15) down over end of oil cooler element until it contacts gasket.

17 Hold filter head (15) in this position, and install capscrews, lockwashers, and washers (16). Tighten six capscrews to 35 ft-lbs (45 N•m) torque.

18 Install capscrews (17) through cooler housing (3) and install gasket (18) over capscrews.



19 Position oil cooler support (19) on cooler housing (3).

20 Tighten six capscrews (17) to 35 ft-lbs (45 N•m) torque.

21 Install oil cooler assembly in accordance with paragraph 2-52.

3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection/Repair d. Assembly e. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Arbor press

Inside micrometer, 1 - 2 inch (Item 4, Appendix B)

Outside micrometer, 1 - 2 inch (Item 36, Appendix B)

Radius gauge, 0.25-inch (6.35 mm)

Two suitable guide studs

Mandrel (Item 30, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Prussian blue (Item 24, Appendix C)

Lubricating oil (Item 22, Appendix C)

Adhesive sealant (Item 3, Appendix C)

Materials/Parts (Cont)

Suitable block

Gaskets

O-rings

Locknuts

Equipment Condition Reference	**Condition Description**
Paragraph 2-47	Aftercooler air crossover connection removed
Paragraph 2-53	Rocker lever cover assemblies removed
Paragraph 3-27	HVT valve disconnected from rocker lever housing

General Safety Instructions

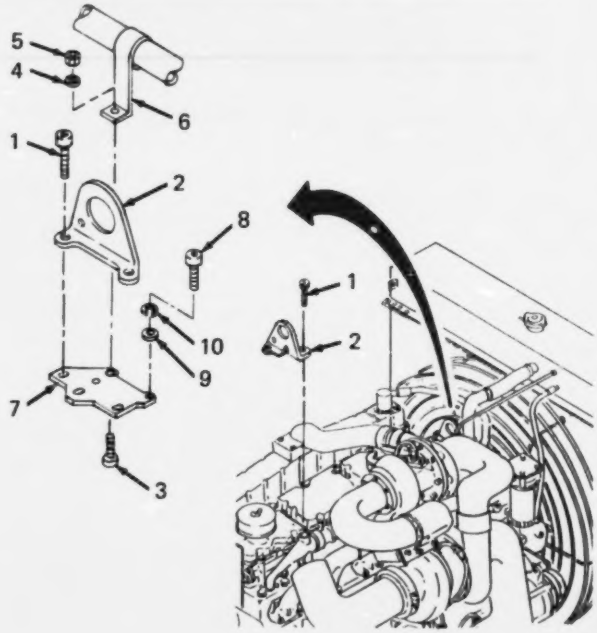
Well ventilated area for steam cleaning

REMOVAL:

1 Remove four capscrews (1) that secure two lifting brackets (2) to engine and remove lifting brackets.

2 Remove capscrew (3) with lockwasher (4), and nut (5), that secure aftercooler water tube support bracket (6) to fan brace (7).

3 Remove two capscrews (8) with washers (9) and lockwashers (10) and remove fan brace (7).



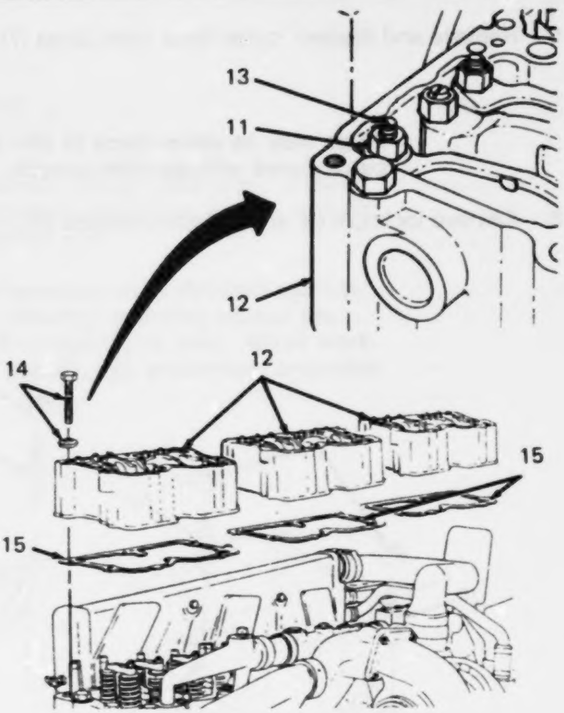
3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

4 Loosen six rocker lever adjusting screw locknuts (11) in each rocker lever housing (12).

5 Turn six adjusting screws (13) in each rocker lever housing (12) counterclockwise two full turns.

6 Remove six screws and captive washer assemblies (14) from each rocker lever housing (12).

7 Remove rocker lever housings (12) with gaskets (15).



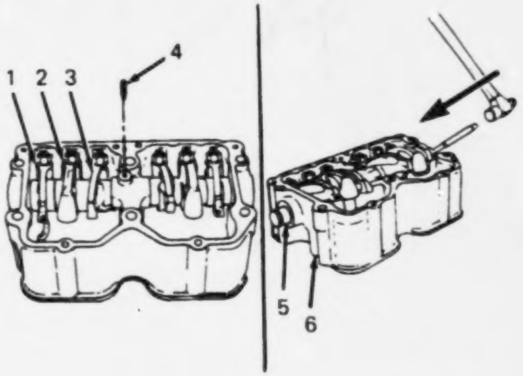
DISASSEMBLY:

1 To prevent increased wear, mark each rocker lever (1, 2, and 3) so they can be installed back in their original locations.

2 Remove rocker lever shaft screw (4).

3 Remove rocker lever shaft (5) using flat or drift punch to push shaft through housing (6). Be careful not to damage bore in housing.

4 Remove rocker levers (1, 2, and 3) as shaft (5) is removed.



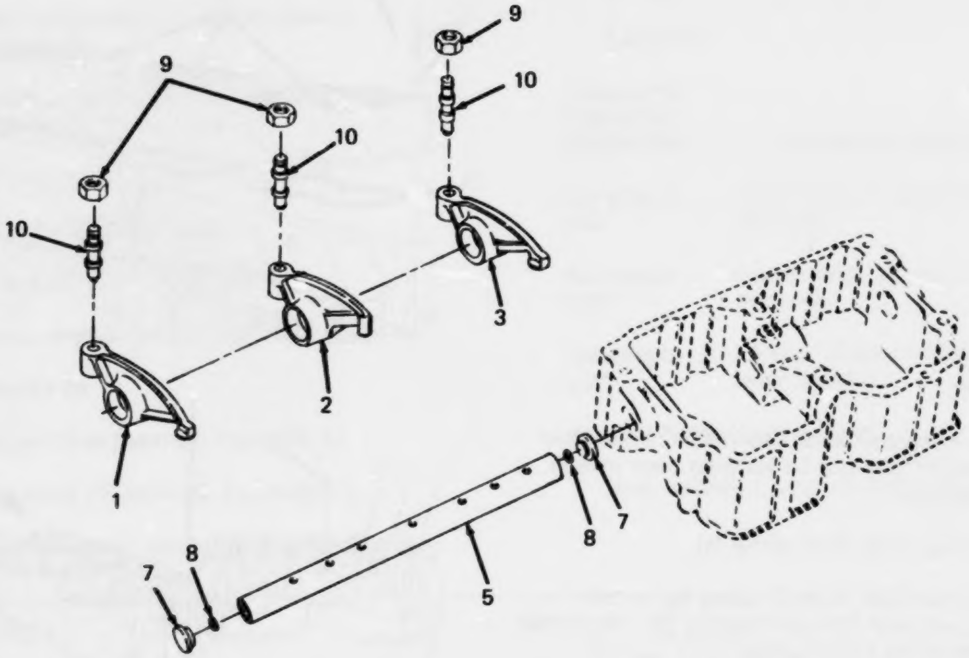
3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

5 Remove and discard rocker lever shaft plugs (7) and O-rings (8) from each end of rocker lever shaft (5).

NOTE

Plugs may be either force fit into shaft or threaded. Threaded plugs must be removed with an allen wrench.

6 Remove locknuts (9) and adjusting screws (10) from rocker levers (1, 2, and 3).



3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean components as follows:

   a. Steam clean rocker lever housings (1), being sure that breather vent holes (2) are free of dirt and deposits.

   b. Dry housing with compressed air.

   c. Steam clean rocker lever shafts (3) using a bottle brush to clean shaft bore.

   d. Dry shafts with compressed air.

   e. Steam clean rocker levers (4), being sure to blow out oil passages.

   f. Dry rocker levers with compressed air.

2 Visually inspect rocker lever housings (1) for cracks or damage; replace if necessary.

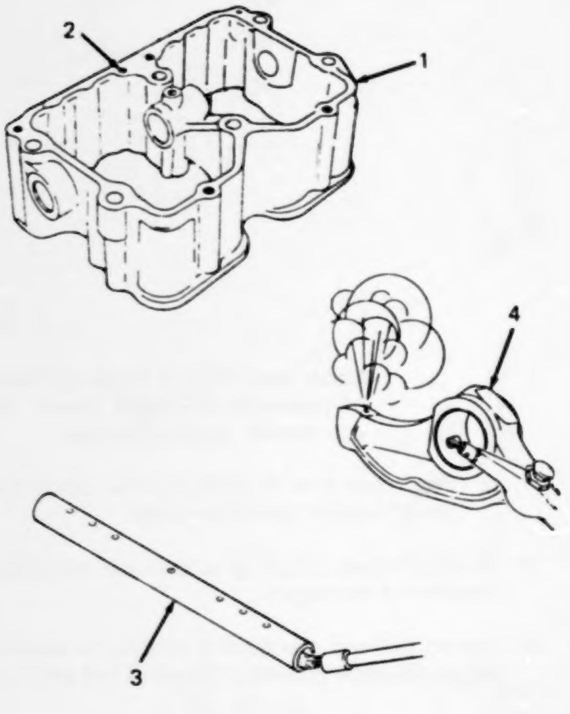
3 Inspect capscrew holes in housings (1) for damaged threads. Repair threads as required.

4 Inspect bore in rocker lever housing (1) for burrs or sharp edges. Remove any burrs or sharp edges.

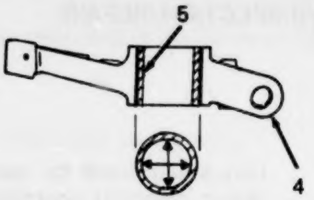
5 Visually inspect rocker lever shafts (3) for cracks or damage.

6 Visually inspect thread condition of shafts with internal threads.

7 Measure rocker lever shaft (3) outside diameter in bushing near area. Shaft outside diameter should be between 1.122 inches (28.5 mm) and 1.124 inches (28.55 mm). Replace shaft if not within these limits, or if shaft has ridges worn in it.



3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)



8 Visually inspect rocker levers (4) for cracks, unusual wear, or damaged threads; replace if necessary.

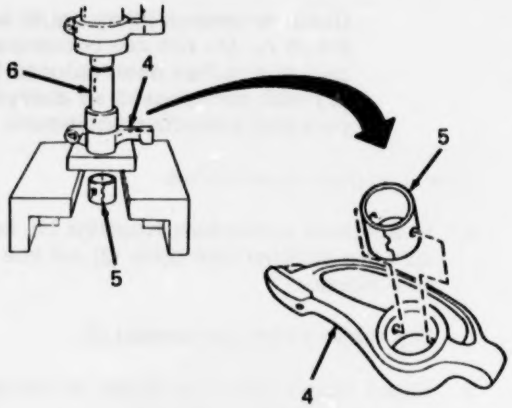
9 Inspect lever bushings (5) for cracks or pitting.

10 Measure lever bushing (5) inside diameter while installed. Bushing inside diameter should be between 1.1245 inches (28.562 mm) and 1.286 inches (28.666 mm).

11 If lever bushings are cracked, pitted, or worn beyond tolerances, replace as follows:

a. Place rocker lever (4) on block and insert mandrel (6) into bore of lever bushing (5).

b. Apply force of arbor press to mandrel (6) and drive lever bushing (5) out of rocker lever (4).



CAUTION

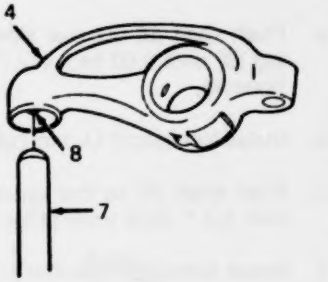
Make sure that oil holes in replacement bushings are properly aligned with oil passages in rocker levers. Failure to do so will cause lubrication failure and severe engine damage.

c. Press new lever bushing (5) into rocker levers, with oil holes aligned with rocker lever (4) oil passages using mandrel and arbor press.

12 Visually inspect adjusting screws and adjusting screw nuts for thread damage. Replace component if threads are damaged.

13 Inspect ball end of adjusting screws for scratches and wear. Check with a 0.25 inch (6.35 mm) radius gauge. Replace adjusting screws if ball end is damaged.

3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)



14 Check injector rocker lever (4) socket seat as follows:

- a. Coat ball end of new injector link (7) with prussian blue.
- b. Place ball end of injector link (7) into socket seat (8) and rotate using hand pressure.
- c. Check seat (8) wear area. If wear area is not 80 percent blued, replace socket seat.

ASSEMBLY:

NOTE

Lightly oil all parts before assembly.

1 Install adjusting screw (1) and adjusting screw nut (2) in each rocker lever (3, 4, and 5). Do not tighten nuts.

NOTE

If the plugs are threaded type, hold one plug with an allen wrench while tightening the other plug to 70 ft-lbs (95 N·m) torque.

2 Install two O-rings (6) and plugs (7) in each rocker lever shaft (8).

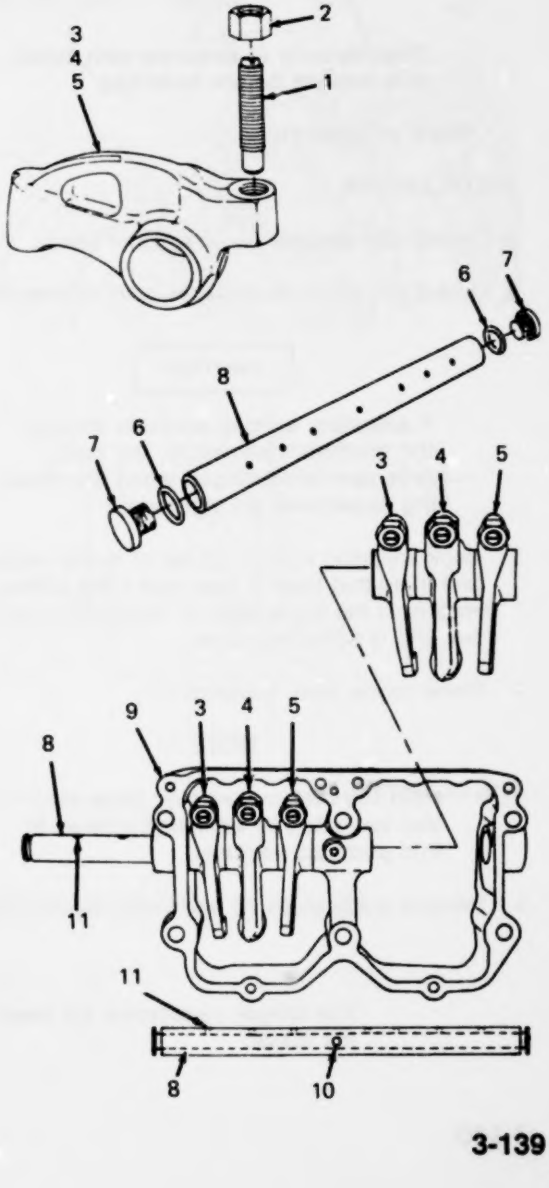
CAUTION

The setscrew hole and seven oil passage holes must be positioned properly. Failure to do so will cause severe engine damage.

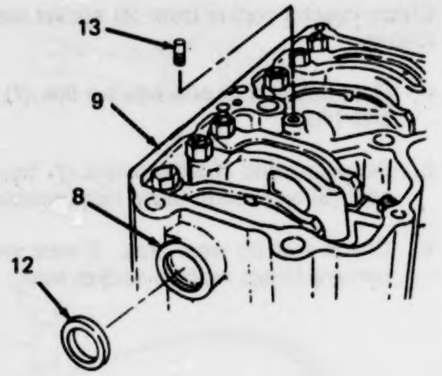
3 Push shaft (8) into housing (9) with setscrew hole (10) to the top and seven oil passage holes (11) toward flat side of housing.

4 Install exhaust (3), injector (4), and intake (5) rocker levers as shaft (8) is pushed through left side of housing (9).

5 Install intake (5), injector (4), and intake (3) rocker levers as shaft (8) continues into right side of housing (9).



3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)



6 Install O-rings (12) as follows:

- a. Push shaft (8) out one side of rocker arm housing (9) until 0.50 inch (12.7 mm) extends from housing.
- b. Install lubricated O-ring (12) to shaft (8).
- c. Push shaft (8) so that other end extends 0.50 inch (12.7 mm) from other side of housing (9).
- d. Install second lubricated O-ring (11) to shaft (8).

7 Align setscrew holes in shaft (8) and housing (9).

NOTE

Coat threads of setscrew with adhesive sealant before installing.

8 Install setscrew (13).

INSTALLATION:

1 Install new gaskets (1) on cylinder heads.

2 Install two guide studs (2) in each cylinder head.

CAUTION

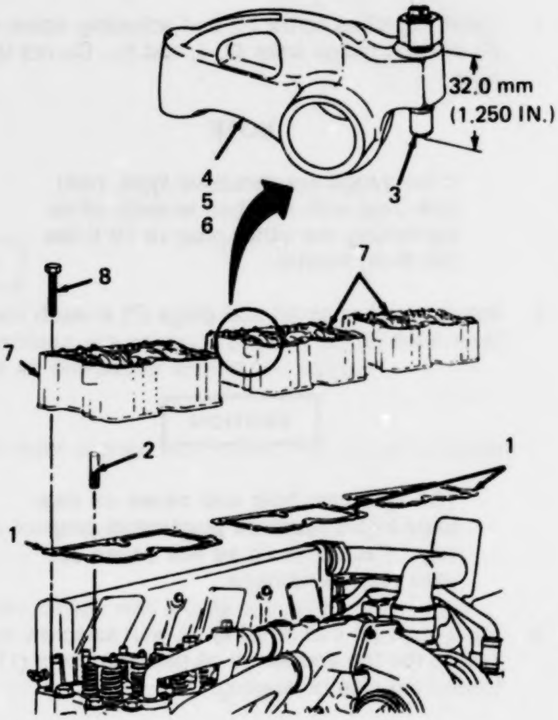
If adjusting screws protrude beyond the maximum allowable, the push rods can be damaged when the housing capscrews are tightened.

3 Back adjusting screws (3) out of rocker levers (4, 5, and 6) so that there is less than 1.250 inches (32 mm) from the top surface of rocker lever and the ball end of adjusting screw.

4 Install rocker lever housings (7).

NOTE

Hold the rocker levers in place so that ball ends of adjusting screws fit into pushrod sockets.



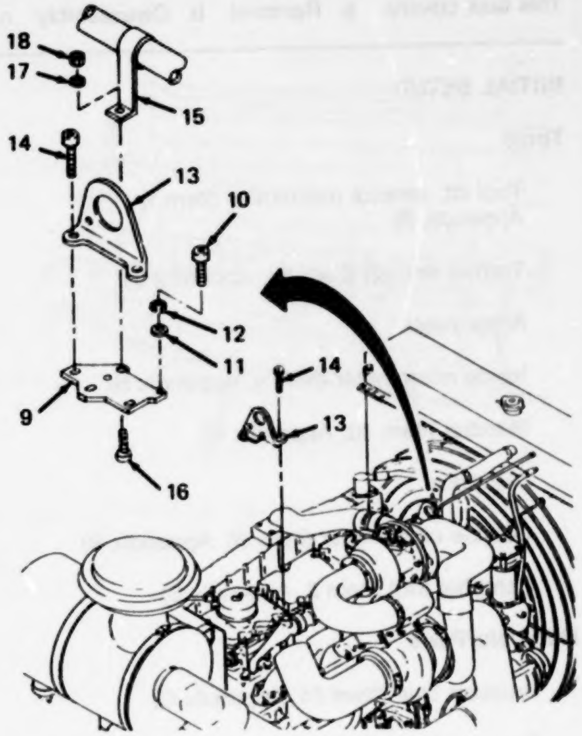
5 Remove guide studs (2) and install shorter capscrews (8) hand tight.

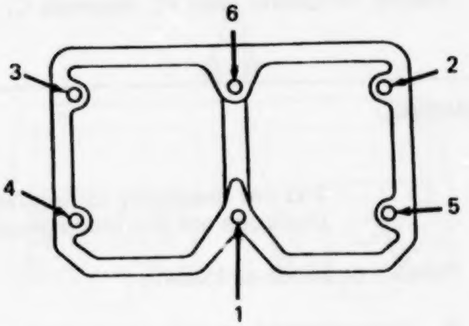
NOTE

The longer capscrews are used to secure the engine lifting brackets and fan brace.

3-33. ROCKER LEVER HOUSING ASSEMBLY REPAIR/REPLACE (CONT)

6. Install fan brace (9) using two capscrews (10), washers (11), and lockwashers (12).
7. Install two lifting brackets (13) using capscrews (14) screwed in hand tight.
8. Install aftercooler water tube support bracket (15) to fan brace (9) using capscrew (16), lockwasher (17), and nut (18).
9. Tighten capscrews (8 and 14), that secure rocker lever housings (7), in the sequence shown to 60 ft-lbs (80 N•m) torque.
10. Adjust injectors in accordance with paragraph 3-39.
11. Adjust rocker levers in accordance with paragraph 2-54.
12. Install rocker lever cover assembly in accordance with paragraph 2-53.
13. Install aftercooler air crossover connection in accordance with paragraph 2-47.





3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection/Repair d. Assembly e. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 38, Appendix B)

Arbor press

Inside micrometer (Item 4, Appendix B)

Mandrel (Item 30, Appendix B)

Drill press

Outside micrometer (Item 36, Appendix B)

Campher tool (Item 2, Appendix B)

Materials/Parts

Prussian blue (Item 24, Appendix C)

Dry cleaning solvent (Item 30, Appendix C)

Sealing compound (Item 27, Appendix C)

Materials/Parts

Lubricating oil (Item 22, Appendix C)

Gaskets

Expansion plugs

Equipment Condition Reference	Condition Description
Paragraph 2-47	Air crossover connection removed
Paragraph 2-53	Rocker housing covers removed
Paragraph 3-29	Fuel pump removed
Paragraph 3-30	Accessory drive assembly removed

General Safety Instructions

Well ventilated area

REMOVAL:

NOTE

It is not necessary to remove the fuel pump and accessory drive if the pushrods are the only component to be replaced.

1 Remove pushrods as follows:

a. Loosen locknut on each rocker lever adjusting screw.

b. Loosen adjusting screw.

NOTE

To prevent increased wear, mark each pushrod as it is removed so it can be installed back in its original location.

Some pushrods are under compression due to the valves being open. Rotate the crankshaft clockwise with the accessory drive pulley to relieve the spring tension.

3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

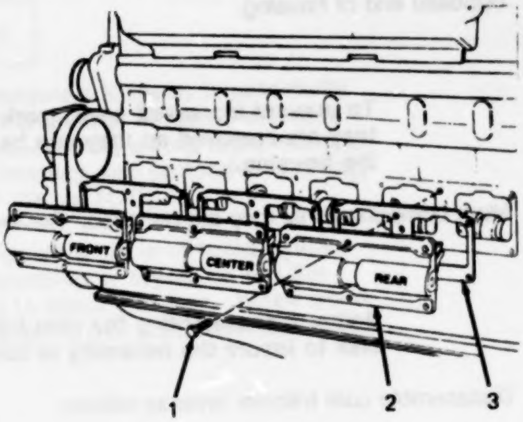
c. Remove pushrods.

2 Remove cam follower housing as follows:

a. Remove six capscrews (1) from each cam follower housing (2).

NOTE

To prevent increased wear, mark the cam follower housing assemblies as they are removed so they can be installed back in their original location on the block.



b. Carefully pry cam follower housing (2) from dowel pins and remove housing and gasket (3).

NOTE

The thickness of the gaskets controls the injection timing.

c. Measure and record thickness of gaskets used between each cam follower housing and block.

d. Discard the gaskets.

DISASSEMBLY:

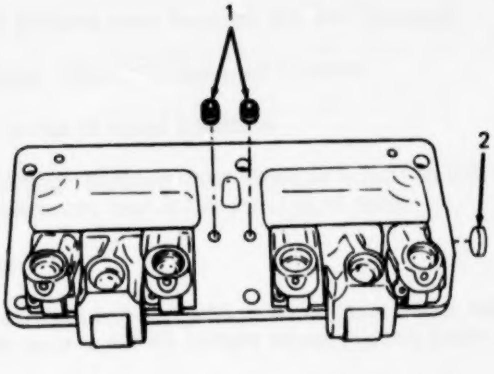
1 Remove two locking shaft screws (1) for each assembly.

2 Remove expansion plug (2) from each assembly as follows:

a. Use a punch with sharp point to make a hole in center of plug.

b. Hit one edge of plug to loosen it.

c. Use pliers to remove plug and discard plug.



3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

3 Install mandrel in arbor press. Push mandrel against shafts in housing to move plug out of the hole in opposite end of housing.

NOTE

To prevent increased wear, mark the cam follower shafts and the levers as they are removed so they can be installed back in their original positions in the housing.

4 Mark components as they are removed. Remove shafts and cam follower levers from housing.

NOTE

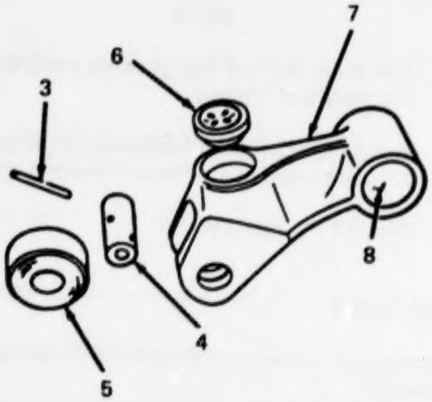
Before disassembling the cam follower lever perform Cleaning/Inspection task to insure the necessity of further disassembly.

5 Disassemble cam follower lever as follows:

a. Remove roller retainer pin (3) and remove roller pin (4) and roller (5).

b. Remove push tube insert (6) from cam follower lever (7).

c. Using arbor press and mandrel, remove bushing (8) from cam follower lever (7).



3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean, inspect, and repair cam follower parts as follows:

a. Clean cam follower parts with dry cleaning solvent and dry with compressed air.

b. Visually inspect cam follower shafts for scoring or damage.

c. Use micrometers to measure outside diameter of shaft. Shaft must measure 0.7485 to 0.7490 inch (18.012 to 19.02 mm). Replace shaft if it is damaged or outside diameter measures less than 0.748 inch (19.00 mm).

d. Visually inspect locking screw holes for damaged or distorted threads.

e. Visually inspect locking screw grooves in each shaft. The grooves must be clean and not damaged.

f. Visually inspect cam follower housings for cracks or damage. Discard if damaged or worn.

g. Visually inspect cam follower bushing for breaks, cracks, or out of round condition.

h. Use inside micrometers to measure inside diameter of bushing. Bushing must measure 0.7501 to 0.7511 inch (19.053 to 19.078 mm). Replace bushing if it measures more than 0.752 inch (19.10 mm).

i. Visually inspect cam follower levers for breaks and cracks.

j. Visually check push tube insert by using a new push tube. Coat ball end with prussian blue. Place ball end of push tube into push tube insert and rotate. If wear area is not 80 percent blued, replace push tube insert.

3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

k. Visually inspect cam follower roller pin for cracks or out of round condition. Measure outer diameter with micrometer. Replace if outer diameter is less than 0.497 inch (12.62 mm).

l. Visually inspect exhaust and intake valve cam rollers for breaks, cracks, or out of round condition. Set telescoping gage to 0.503 inch (12.83 mm). Place gage into inner diameter of roller. If gage slides into roller it is worn beyond wear limit and must be replaced. Measure outer diameter with a micrometer. If outside diameter of roller is less than 1.248 inches (31.71 mm), replace.

m. Visually inspect fuel injector cam rollers for breaks, cracks, or out of round condition. Set telescoping gage to 0.505 inch (12.78 mm). Place gage into inner diameter of roller. If gage slides into roller it is worn beyond wear limit and must be replaced. Measure outer diameter with micrometer. If outer diameter of roller is less than 1.248 inches (31.71 mm), replace.

n. Visually inspect the cam follower shaft for cracks and defects. Measure the outside diameter of the shaft. Replace the shaft if it measures less than 0.748 inch (19 mm). Normal diameter should be 0.7485 inch to 0.7490 inch (18.012 to 19.02 mm).

NOTE

If the rollers are damaged, be sure to inspect the camshaft for damage. Replace any part that is damaged or worn beyond the limits.

2 Clean, inspect, and repair pushrods as follows:

a. Clean pushrods with dry cleaning solvent and dry with compressed air.

b. Visually inspect ball and socket ends of pushrods for uneven wear or scratches.

c. Inspect straightness of pushrod by rolling it on a level bench. Replace pushrod if bent.

d. Inspect for engine oil in pushrods as follows:

(1) Hold pushrod horizontally and drop it from a height of 6 inches on concrete floor or metal surface.

(2) The pushrod may be used if a ringing sound is heard.

(3) If a dull (or non-ringing) sound is heard, the pushrod contains engine oil and must be discarded.

ASSEMBLY:

1 Assemble cam follower lever as follows:

NOTE

Lightly oil all parts before reassembly.

If new push tube insert is being installed, a new push tube must also be used.

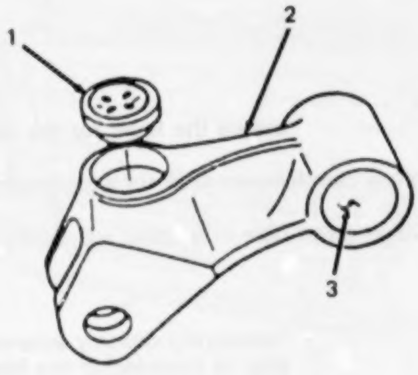
3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

a. Using arbor press, install push tube insert (1) into cam follower lever (2).

b. Assemble cam follower lever bushing (3) as follows:

   (1) Using arbor press and mandrel, install cam lever bushing (3) into cam follower lever (2) and align oil hole in bushing with oil hole in lever.

   (2) Cut a chamfer on each end of bushing. Use drill press at slow speed and chamfer tool that cuts a 60 degree angle chamfer. Clean all metal chips from bushing surfaces.



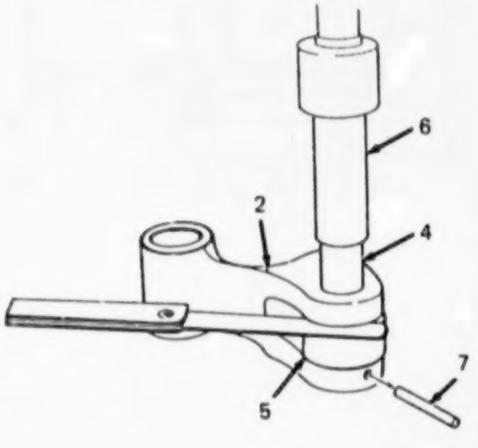
c. Assemble roller pin (4) and cam roller (5) as follows:

   (1) Place cam roller (5) into cam follower lever (2).

   (2) Hold a 0.006 inch (0.15 mm) feeler gauge between lever (2) and cam roller (5).

   (3) Using arbor press and mandrel (6), install roller pin (4) through lever (2) and cam roller (5).

   (4) Install retainer pin (7) into lever (2) and roller pin (4).



3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

2 Position six cam follower levers into cam follower housing in premarked positions.

CAUTION

Insure the lever for the injector is in the center position in each assembly.

3 Slide cam follower shaft through housing and levers.

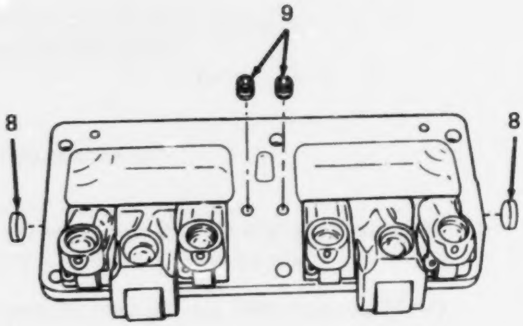
4 Align screw hole in housing with screw hole in shaft and install temporary dummy screws.

NOTE

Temporary dummy screws will prevent breakage of the lockscrew when the plug is installed in the housing.

5 Coat new plugs (8) with sealing compound and press into housing until flush or not more than 0.010 inch (0.25 mm) below edge of hole.

6 Remove temporary screws and install lockscrews (9) in shafts.



3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

INSTALLATION:

1 Install new cam follower gaskets as follows:

NOTE

One gasket is required for each cam follower housing.

The gasket must be installed against the block with the sealing bead toward the cam follower housing.

a. Gaskets ordered from TM 5-4320-307-24P are listed as a compressed thickness. Insure new gasket ordered matches thickness of old gasket measured.

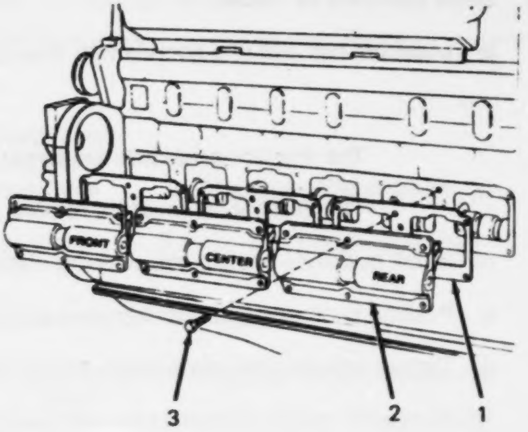
b. Position gasket (1) (with sealing bead outward) over dowels.

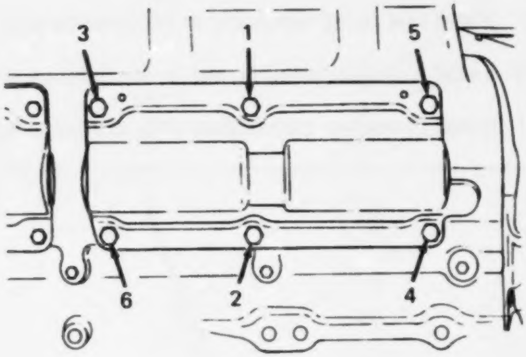
2 Position cam follower assembly (2) on dowel pins in block.

3 Install six capscrews (3) in each cam follower housing.

4 Tighten capscrews (3) in alternating sequence shown to the following torque values:

15 ft-lbs (20 N-m)
35 ft-lbs (45 N-m)





3-34. CAM FOLLOWER INSPECT/REPAIR/REPLACE (CONT)

5 Install pushrods as follows:

  a. Lubricate ball end of pushrods with clean oil.

NOTE

The injector pushrods are larger in diameter than the valve pushrods.

The crankshaft must be rotated clockwise to install all the pushrods.

  b. Install pushrods in the corresponding numbered location.

  c. Position pushrods under rocker lever adjusting screws.

  d. Tighten adjusting screws enough to hold pushrods in position.

6 Adjust injector valves in accordance with paragraph 3-35.

7 Adjust intake and exhaust valves in accordance with paragraph 2-54.

8 Install accessory drive assembly in accordance with paragraph 3-30.

9 Install fuel pump assembly in accordance with paragraph 3-29.

10 Install rocker housing covers in accordance with paragraph 2-53.

11 Install crossover connections in accordance with paragraph 2-47.

3-35. INJECTORS INSPECT/REPLACE

This task covers: a. Removal b. Inspection c. Installation d. Operational Test

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Manual References

TM 5-4320-307-10

Equipment Condition

Reference	Condition Description
Paragraph 2-53	Rocker lever cover assembly removed

General Safety Instructions

Well ventilated area required for operational check.

REMOVAL:

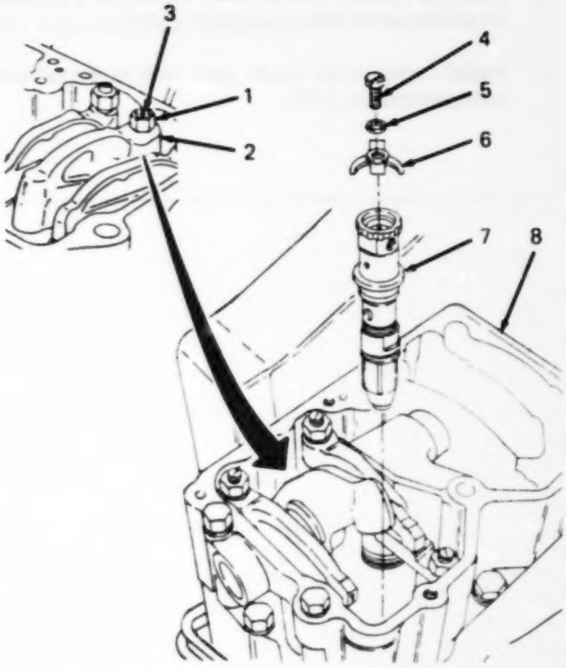
1 Loosen adjusting screw locknut (1) on each injector rocker lever (2).

2 Turn out adjusting screw (3) on each injector rocker lever (2) and move pushrod to the side.

3 Rotate each rocker lever (2) up on each cylinder.

4 Remove capscrew (4), washer (5), and injection clamp (6) securing injector (7) to cylinder head (8).

5 Remove injector (7).



3-35. INJECTORS INSPECT/REPLACE (CONT)

INSPECTION:

1 Check injector cup tip for clogged holes.

2 Check for excessive carbon buildup in injector cup hole.

NOTE

Notify general support maintenance if injectors require cleaning or any further maintenance.

INSTALLATION:

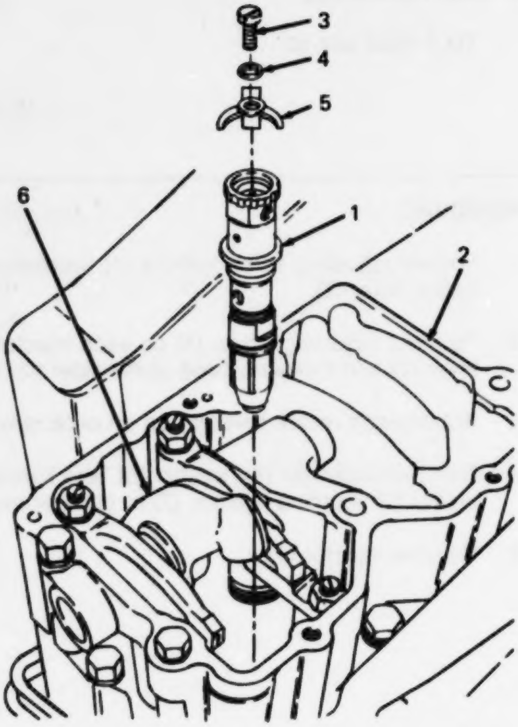
1 Position injector (1) in cylinder head (2).

2 Install capscrew (3), washer (4), and injector clamp (5) securing injector (1) to cylinder head (2).

3 Move pushrod under rocker lever (6).

4 Perform injector rocker lever adjustment procedures in accordance with paragraph 2-54.

5 Install rocker lever cover assembly in accordance with paragraph 2-53.



3-35. INJECTOR INSPECT/REPLACE (CONT)

OPERATIONAL CHECK:

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engine become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

1 Start engine in accordance with TM 5-4320-307-10.

2 Check engine for smooth engine operation.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Razor blade scraper

Torque wrench adapter (Item 38, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Gasket, cylinder head

Dry cleaning solvent (Item 30, Appendix C)

Lubricating oil (Item 22, Appendix C)

Fuel crossover O-rings

Lint free rags (Item 19, Appendix C)

Suitable wooden blocks

Wire brush

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-35	Cooling system drained
Paragraph 2-47	Aftercooler assembly removed
Paragraph 2-53	Rocker housing covers removed
Paragraph 2-40	Turbochargers removed
Paragraph 2-46	Exhaust manifold removed
Paragraph 2-45	Water manifold removed
Paragraph 3-33	Rocker lever housing removed
Paragraph 3-35	Injectors removed

General Safety Instructions

Well ventilated area

Personnel Required

Two

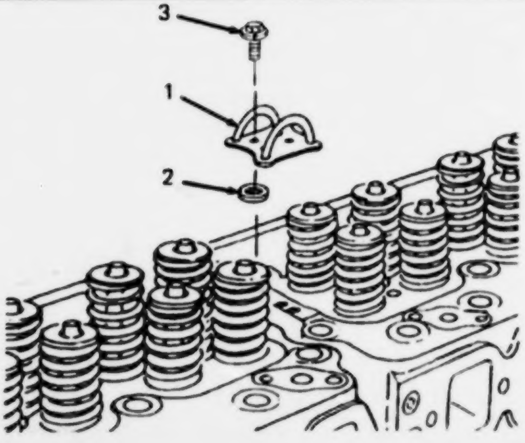
REMOVAL:

1 Remove valve crossheads.

2 Remove fuel supply and fuel drain tubes.

3 Remove all necessary brackets and clamps.

4 Remove two fuel crossover connections (1) and O-rings (2) by removing capscrews and lockwashers (3).



3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

5 Remove 12 capscrews and washers from each cylinder head.

WARNING

Because the cylinder head assembly weighs more than 50 lbs (23 kg), two people or a hoist will be required to lift the cylinder heads to avoid personal injury.

CAUTION

To prevent damage to the head gasket surface, put the cylinder heads on wooden blocks when they are removed.

NOTE

To prevent increased wear, mark each cylinder head as it is removed so it can be installed back in its original location.

6 Lift cylinder heads from block and remove cylinder head gaskets.

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean and inspect cylinder block as follows:

a. Place a clean, lint-free rag in each push rod cavity in cylinder block.

b. Use gasket scraper to remove heavy dirt and debris from head gasket surface of cylinder block.

c. Use razor blade scraper and solvent to remove any remaining material from cylinder block surface.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

d. Clean with dry cleaning solvent and dry with compressed air.

NOTE

Remove the rags after the cylinder block is cleaned.

2 Clean and inspect the cylinder block as follows:

a. Steam clean cylinder heads and dry with compressed air.

b. Blow out all capscrew holes, fuel passages, and oil passages.

c. Use gasket scraper to remove heavy dirt and debris from cylinder head gasket surface, exhaust manifold gasket surface, and rocker housing gasket surface.

d. Use razor blade scraper and solvent to remove any remaining material from cylinder head gasket surface, exhaust manifold gasket surface, and rocker housing gasket surface.

e. Clean with dry cleaning solvent and dry with compressed air.

f. Inspect cylinder head for cracks or damage.

NOTE

If a crack in a cylinder head is suspected, notify general support maintenance for pressure testing and repair.

g. Inspect valves for indications of leakage or burning.

NOTE

If indications of leakage or burning are found, the valves and the seats must be resurfaced. Notify general support maintenance for repair.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

3 Clean and inspect cylinder head capscrews as follows:

CAUTION

Do not use caustic or acid solutions to clean the cylinder head capscrews.

a. Clean the capscrews with dry cleaning solvent.

b. Clean capscrews thoroughly with wire brush, wire wheel (soft), or non-abrasive bead blast to remove deposits from shank and threads.

NOTE

Do not reuse a capscrew that has damaged threads or a reduced diameter from having been stretched.

c. Inspect cylinder capscrews for the following:

(1) Damaged threads.

(2) Reduced diameter (due to capscrew stretching).

(3) Corrosion or pitting exceeding 0.005 inch (0.12 mm) in depth.

(4) Corrosion or pitting located within 1/8 inch (3.2 mm) of fillet or threads.

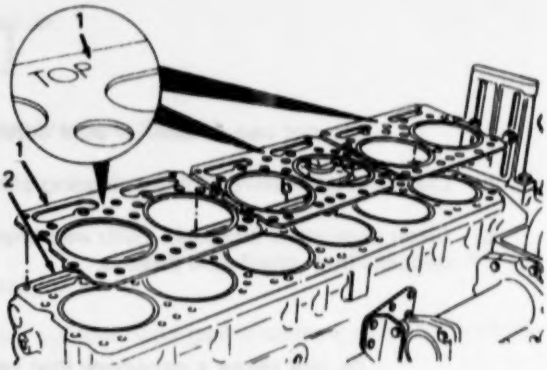
d. Immediately after cleaning and inspecting, apply a film of clean engine lubricating oil to capscrews that are to be used again.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

INSTALLATION:

NOTE

Make sure the side of the gasket marked TOP is up.



1 Install new gaskets (1) on dowel pins in cylinder block (2).

2 Install two guide studs in the block for each cylinder head.

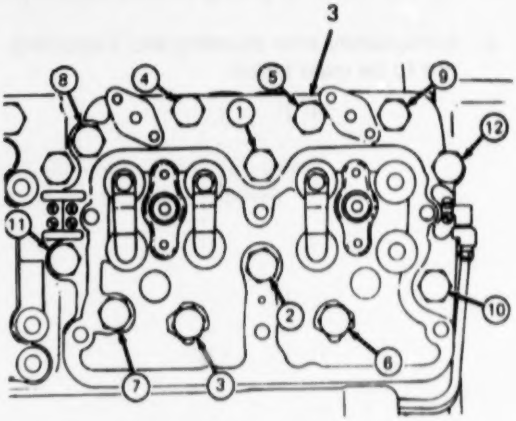
3 Install cylinder heads over guide studs and dowel pins.

4 Remove guide studs.

5 Use clean oil to lubricate cylinder head capscrews and both sides of flat washers.

6 Allow excess oil to drain from threads.

7 Install 12 capscrews and washers in each cylinder head.



8 Torque cylinder head capscrews (3) in sequence shown as follows:

   a. 25 ft-lbs (35 N•m)

   b. 100 ft-lbs (135 N•m)

   c. 285 ft-lbs (385 N•m)

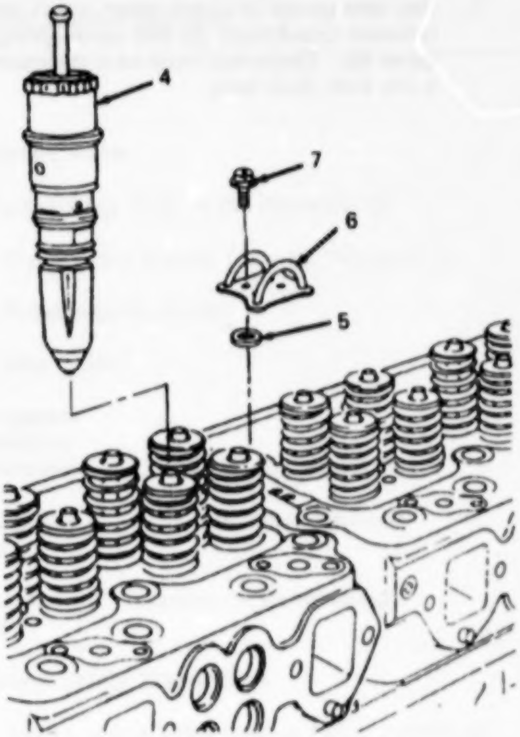
   d. Repeat steps a, b, and c for each cylinder head.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

9 Install injectors (4) in accordance with paragraph 3-34.

10 Install new O-rings (5) and position two fuel crossover connections (6) in place on cylinder heads.

11 Install capscrews and lockwashers (7) and tighten to 35 in-lbs (4 N•m) torque.



12 Install fuel supply and fuel drain tubes.

13 Install all brackets and clamps.

14 Install valve crossheads as follows:

a. Lubricate valve stems and crosshead guides with clean oil.

b. Install crossheads on crosshead guides with adjusting screw toward water manifold side of engine.

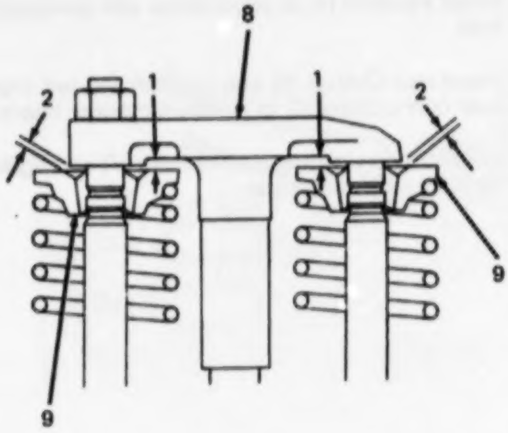
c. Loosen adjusting screw locknut. Loosen adjusting screw one full turn.

d. Use light finger pressure to hold crosshead in position, and tighten the adjusting screw until it touches top of valve stem.

e. Hold crosshead adjusting screw in position, and tighten the locknut to 30 ft-lbs (40 N•m) torque. If torque wrench adapter is used, tighten the locknut to 25 ft-lbs (35 N•m) torque.

3-36. CYLINDER HEAD ASSEMBLY/INSPECT/REPLACE (CONT)

f. Use wire gauge to check clearance (1 and 2) between crossheads (8) and valve spring retainer (9). Clearance must be a minimum of 0.025 inch (0.65 mm).



NOTE

The injector push rods are larger in diameter than the valve pushrods.

15 Install rocker lever housings in accordance with paragraph 3-33.

16 Adjust valves and injectors in accordance with paragraph 2-54.

17 Install water manifold in accordance with paragraph 2-45.

18 Install exhaust manifold in accordance with paragraph 2-46.

19 Install turbochargers in accordance with paragraph 2-40.

20 Install rocker housing covers in accordance with paragraph 2-53.

21 Install aftercooler assembly in accordance with paragraph 2-47.

22 Fill cooling system in accordance with paragraph 2-35.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN

This task covers: a. Removal b. Cleaning/Inspection c. Installation/Alignment

INITIAL SETUP

Test Equipment

Crack detection kit

Dial indicator (Item 5, Appendix B)

Tools

Reamer (Item 3, Appendix B)

Drill (Item 2, Appendix B)

Torque wrench (Item 2, Appendix B)

Tool kit, general mechanics (Item 1, Appendix B)

Rubber hammer

Dowel pin extractor

Suitable lifting device

Materials/Parts

T-handles

Crocus abrasive cloth (Item 1, Appendix C)

Materials/Parts

Lubricating oil (Item 22, Appendix C)

Dry cleaning solvent (Item 25, Appendix C)

Suitable guide studs

Wire brush

Equipment Condition Reference	Condition Description
Paragraph 3-18	Speed increaser removed
Paragraph 2-43	Starting motor removed

General Safety Instructions

Insure proper lifting methods and procedures are followed.

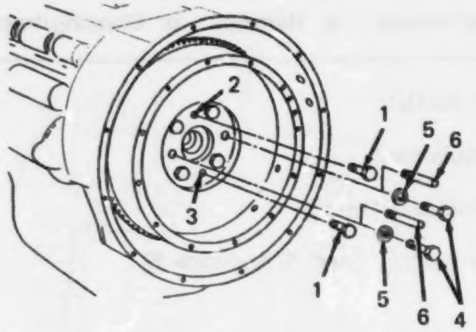
REMOVAL:

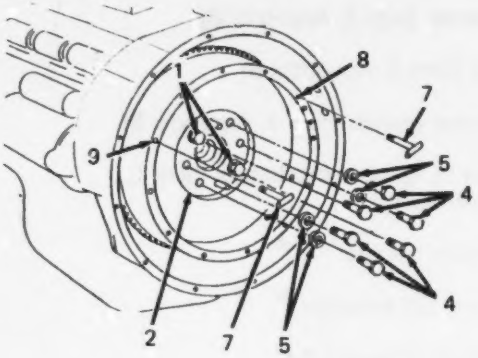
WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)





1 Remove flywheel assembly as follows:

NOTE

Hold the flywheel to prevent rotation.

a. Install two 1/2-13 x 1 1/2 puller capscrews (1) which have a minimum of 1-1/4 inch threaded area at points (2) and (3).

b. Remove two capscrews (4) and washers (5) and install two 5/8-18 x 6-inch guide studs (6).

c. Determine capscrew thread size and install two T-handles (7) in the flywheel at points (8) and (9).

d. Remove remaining four flywheel mounting capscrews (4) with washers (5).

WARNING

Because the flywheel weighs more than 50 lbs (23 kg), a hoist will be required for lifting the flywheel to avoid personal injury.

e. Tighten two puller capscrews (1) at points (2) and (3) in alternating sequence to loosen flywheels.

f. Strap from hoisting device can be wrapped around T-handles (7).

g. Remove flywheel.

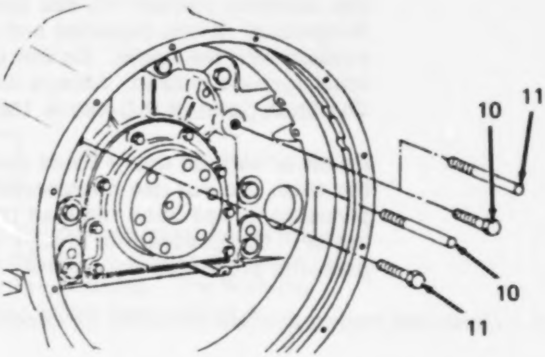
3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

2 Remove flywheel housing as follows:

a. Use suitable lifting fixture to support the rear of engine.

b. Remove capscrews and both rear engine mounts.

c. Remove two capscrews (10) and install two 5/8-18 x 4-inch guide studs (11).



d. Remove seven remaining capscrews.

e. Use rubber hammer to loosen housing from dowels in cylinder block.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean and inspect flywheel assembly as follows:

a. Use wire brush to clean crank shaft pilot bore.

b. Clean flywheel assembly with dry cleaning solvent and dry with compressed air.

c. Visually inspect for nicks or burrs.

d. Use a fine crocus cloth to remove small nicks and burrs.

WARNING

Do not use a cracked or resurfaced flywheel. These can break, causing serious personal injury or property damage.

e. Use crack detection kit to check for cracks in flywheel. Follow instructions provided with kit.

f. Inspect flywheel ring gear teeth for cracks and chips.

NOTE

If the ring gear teeth are cracked or broken the ring gear must be replaced.

2 Clean and inspect flywheel housing as follows:

a. Clean flywheel housing with dry cleaning solvent and dry with compressed air.

b. Visually inspect all surfaces for nicks, burrs, or cracks.

c. Use a fine crocus cloth to remove small nicks and burrs.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

d. Inspect all threaded capscrew holes for damage.

NOTE

If flywheel housing or rear oil seal repair is necessary, notify general support maintenance.

INSTALLATION/ALIGNMENT:

1 Install and align flywheel housing as follows:

CAUTION

If a new flywheel housing is being installed, the dowels must be removed from the cylinder block using a dowel pin extractor or equivalent prior to installing the housing to prevent damage to the housing. The housing must be doweled with an oversize dowel after it has been aligned.

NOTE

Insure the mounting surface of the flywheel housing is clean and free from damage.

a. Install two 5/8-18 x 4-inch guide studs in cylinder block to help support and align housing during installation.

b. Install flywheel housing over guide studs.

c. Tighten the capscrews to 10 to 20 ft-lbs (13.5 to 27.0 N-m) torque.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

d. Remove guide studs and install and tighten remaining capscrews to 10 to 20 ft-lbs (13.5 to 27.0 N·m) torque.

NOTE

Do not fully tighten capscrews until bore alignment is performed.

e. Check the bore alignment as follows:

(1) Attach dial gauge attachment (1) to crankshaft (2).

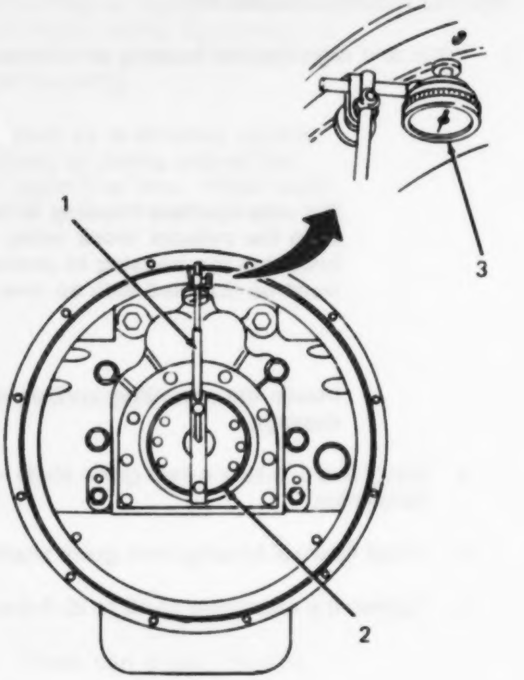
(2) Attach dial gauge (3) to attachment.

(3) Put dial indicator at 12:00 o'clock position. Adjust dial indicator until the needle points to 0 (zero).

(4) Use chalk to mark the housing at 12:00 o'clock, 3:00 o'clock, 6:00 o'clock, and 9:00 o'clock positions.

NOTE

Use the accessory drive shaft to rotate the crankshaft a clockwise direction.



3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

(5) Rotate crankshaft to check housing bore at 3:00 o'clock and 9:00 o'clock. If total indicator reading (TIR) exceeds limits given in specifications, move housing in a horizontal direction 1/2 the distance of total indicator reading. Use pry bar to move housing.

(6) Rotate crankshaft to check housing bore at 12:00 o'clock and 6:00 o'clock. If total indicator reading (TIR) exceeds limits given in specifications, move housing in a vertical direction until reading is within limits.

NOTE

The maximum allowable total indicator reading (TIR) depends on the diameter of the housing bore.

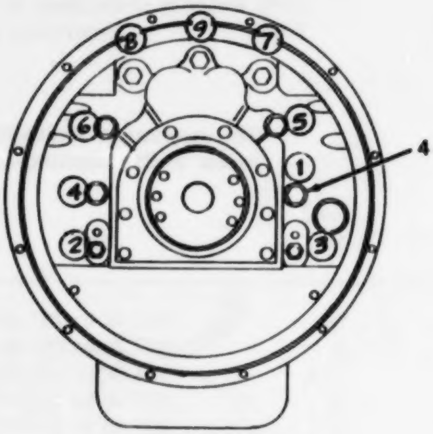
SAE No.	Bore Diameter		Bore Location Tolerance	
	mm	in	mm	in
00	787.40 to 787.65	31.000 to 31.010	0.30	0.012 TIR
0	647.70 to 647.95	25.5000 to 25.510	0.25	0.010 TIR
1/2	584.00 to 584.20	23.000 to 23.008	0.25	0.010 TIR
2	447.68 to 447.80	17.625 to 17.630	0.20	0.008 TIR
3	409.58 to 409.70	16.125 to 16.130	0.20	0.008 TIR

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

NOTE

If the alignment is not within specifications and the bore is not round, the housing must be replaced.

f. If bore alignment specifications are within limits, tighten capscrews (4) in sequence given to 140 to 150 ft-lbs (190 to 217 N-m) torque.



g. Check face alignment as follows:

(1) Attach dial gauge attachment (1) to crankshaft (2).

CAUTION

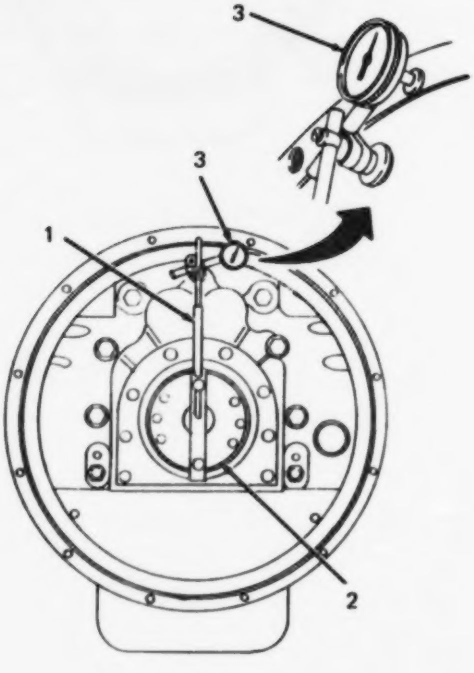
The tip of the gauge must not enter the capscrew holes or the gauge will be damaged.

(2) Attach dial gauge (3) to attachment and put tip of dial gauge (3) against flywheel housing surface.

NOTE

The crankshaft must be pushed toward the front of the engine to remove the crankshaft end clearance each time a point is measured.

(3) Use accessory drive to rotate crankshaft until dial indicator is at 12:00 o'clock position. Push crankshaft toward front of engine. Adjust dial on indicator until needle points to 0 (zero).



3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

(4) Rotate crankshaft and check alignment of face of flywheel housing at 3:00 o'clock, 6:00 o'clock, 9:00 o'clock, and 12:00 o'clock positions.

(5) Determine total indicator run out (TIR).

NOTE

The maximum allowable total indicator reading (TIR) depends on the diameter of the housing bore. See specifications listed in step (i).

(6) If alignment is not within specifications, remove housing. Check for nicks, burrs, or foreign material between block and housing.

(7) Check alignment again. If alignment is not within specifications, replace the housing.

h. Position two rear engine mounts in position on engine and skid. Install capscrews and tighten.

i. Remove lifting fixture used to support engine.

SAE	Bore Diameter		Bore Location Tolerance	
No.	mm	in	mm	in
00	787.40 to 787.65	31.000 to 31.010	0.30	0.012 TIR
0	647.70 to 647.95	25.5000 to 25.510	0.25	0.010 TIR
1/2	584.00 to 584.20	23.000 to 23.008	0.25	0.010 TIR
2	447.68 to 447.80	17.625 to 17.630	0.20	0.008 TIR
3	409.58 to 409.70	16.125 to 16.130	0.20	0.008 TIR

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

NOTE

If the dowel pins were removed from the cylinder block proceed to step (j).

j. Use drill and reaming fixture to ream dowel holes to next oversize.

k. Install dowel pins. Dowels must be even with or 0.010 inch (0.25 mm) below surface of housing that is closest to flywheel.

2 Install and align flywheel as follows:

a. Install two 5/8-18 x 6-inch guide studs (5) in crankshaft flange.

WARNING

Because the flywheel weighs more than 50 lbs (23 kg), a hoist will be required for lifting the part to avoid personal injury.

b. Install flywheel (6) on guide studs (5).

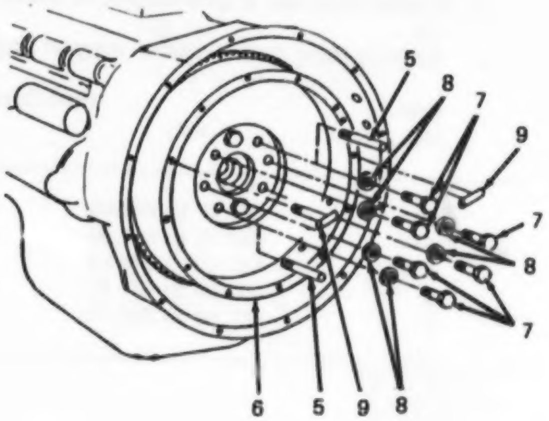
c. Lubricate threads of capscrews (7) and surface of washers (8) with lubricating oil.

d. Install four capscrews (7) with washers (8).

e. Remove two T-handles (9) and two guide studs (5).

f. Install remaining two capscrews (7) with washer (8) in holes from which guide studs were removed.

g. Tighten capscrews (7) in a star pattern to 200 ft-lbs (270 N-m) torque.



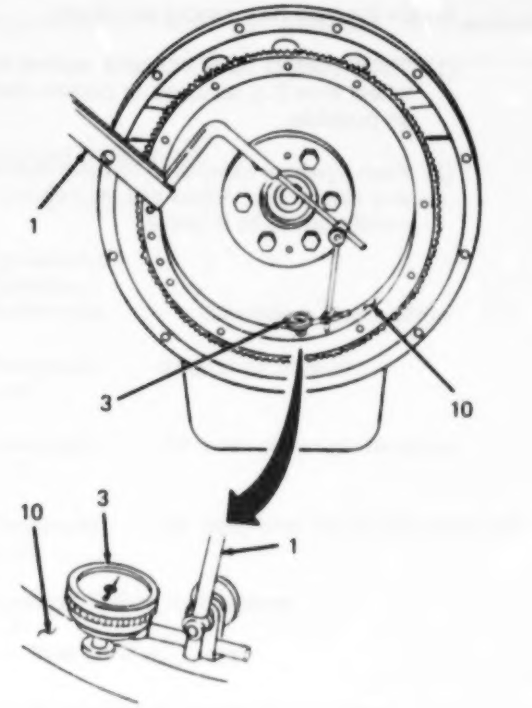
3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

h. Check flywheel bore runout as follows:

(1) Attach dial gauge attachment (1) to the flywheel housing.

(2) Attach dial gauge (3) to attachment.

(3) Install contact tip of indicator against inside diameter of flywheel bore (10) and set dial indicator at 0 (zero).



(4) Using accessory drive shaft, rotate crankshaft one complete revolution.

NOTE

The total indicator reading (TIR) must not exceed 0.0050 inch (0.127 mm).

If the TIR is greater than the specification, proceed to step (5).

(5) If TIR is greater than specification, remove flywheel and inspect flywheel and crankshaft surface for dirt or damage.

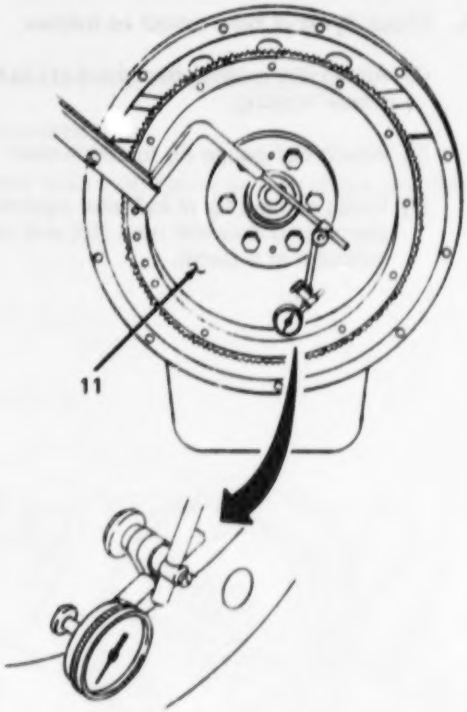
(6) Install flywheel and inspect bore runout once again. Replace flywheel if runout does not meet specifications.

3-37. FLYWHEEL AND FLYWHEEL HOUSING INSPECT/REPLACE/ALIGN (CONT)

l. Check flywheel face runout as follows:

(1) Install contact tip of indicator against flywheel face (11) as close to outside diameter as possible.

(2) Push flywheel forward to remove crankshaft end clearance. Adjust dial on indicator until needle points to 0 (zero).



NOTE

The flywheel must be pushed toward the front of the engine to remove the crankshaft end clearance each time a point is measured.

(3) Using accessory drive shaft, rotate crankshaft one complete revolution. Measure flywheel runout at four equal points on flywheel.

(4) Total indicator reading (TIR) must not exceed the referenced specifications.

Flywheel Radius (A)		Maximum (TIR) of Flywheel Face	
mm	in	mm	in
203	8	0.203	0.008
254	10	0.254	0.010
305	12	0.305	0.012
356	14	0.356	0.014
406	16	0.406	0.016

(5) If TIR is not within specifications, remove flywheel and inspect for nicks, burrs, or foreign material between flywheel mounting surface and crankshaft flange.

j. Install starter motor in accordance with paragraph 2-43.

k. Install speed increaser in accordance with paragraph 3-18.

3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection/Repair d. Assembly e. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Tap and die set

Materials/Parts

Oil pan gasket

Oil suction correction gasket

Hand hole gasket

O-ring seals

Clean vegetable oil (Item 33, Appendix C)

Manual References

TM 750-254

Equipment Condition Reference	Condition Description
Paragraph 2-36	Engine oil drained
Paragraph 2-55	Oil drain assembly removed
Paragraph 3-27	Oil drain lube (HVT) disconnected

General Safety Instructions

Well ventilated area

REMOVAL:

1 Remove oil gauge bracket as follows:

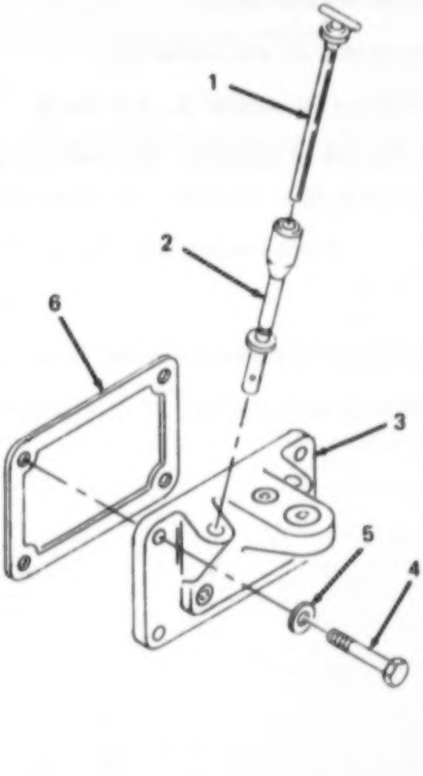
a. Remove oil dipstick (1).

b. Remove oil gauge tube (2) from hand hole cover (3).

c. Remove four capscrews (4) and washers (5).

d. Remove hand hole cover (3) from engine.

e. Remove and discard hand hole gasket (6).



3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE (CONT)

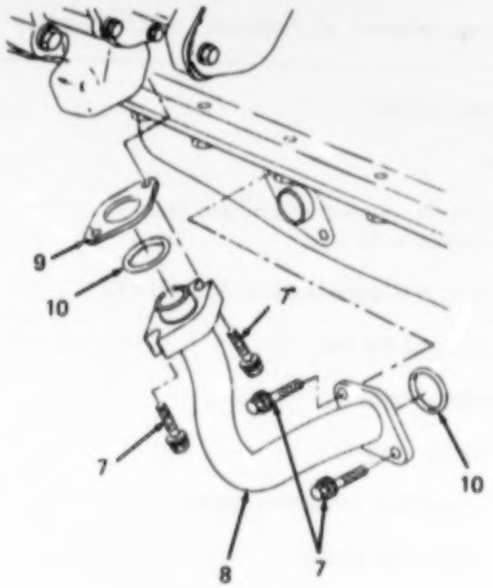
2 Remove oil pan as follows:

   a. Remove four capscrews, washers, and lockwashers (7) from oil transfer tube (8).

   b. Remove and discard oil suction connection gasket (9), O-ring seal (10), and rectangular ring seal.

   c. Remove 36 oil pan mounting capscrews.

   d. Remove oil pan assembly and discard gasket.



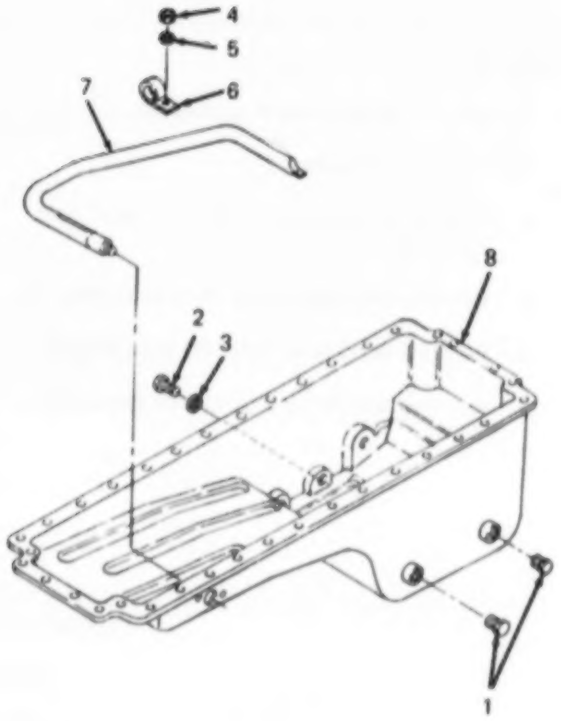
DISASSEMBLY:

1 Remove two pipe plugs (1).

2 Remove plug (2) and washer (3).

3 Remove nut (4), washer (5), and clip (6).

4 Remove lube oil suction tube (7) from oil pan (8).



3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean oil pan and components and dry with compressed air.

2 Remove oil gasket material from cylinder block and oil pan surfaces.

3 Inspect inside and outside of oil pan for cracks around suction tube mounting stud.

4 Inspect for cracked or broken suction tube mounting clip.

5 Inspect for damaged threads and uneven gasket mating surfaces.

6 Repair damaged oil plug threads by installing an oversize drain plug as follows:

   a. To use drain plug, Part No. 62117 with 1-1/4 inch x 12 thread size, proceed as follows:

      (1) Increase diameter of hole to 1-11/64 inch (29.77 mm).

      (2) Use a 1-1/4 inch x 12 tap to cut threads in hole. Use diesel fuel as a lubricant as you cut threads

      (3) Install new drain plug and copper washer. Tighten plug to 60 to 70 ft-lbs (81 to 95 N•m) torque.

   b. To use drain plug, Part No. 120349 with 1-3/8 inch x 12 thread size, proceed as follows:

      (1) Increase diameter of hole to 1-19/64 inch (32.94 mm).

      (2) Use a 1-3/8 inch x 12 tap to cut threads in hole. Use diesel fuel as a lubricant as you cut threads

      (3) Install new drain plug and copper washer. Tighten plug to 60 to 70 ft-lbs (81 to 95 N•m) torque.

3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE (CONT)

NOTE

Welding of machined surfaces is not permitted.

7 Weld any small cracks in oil pan in accordance with TM 750-254.

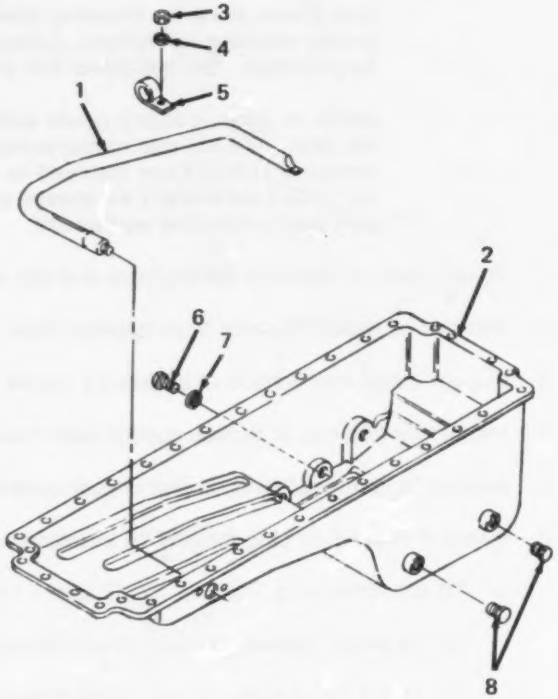
ASSEMBLY:

1 Place lube oil suction tube (1) in oil pan (2).

2 Install nut (3), washer (4), and clip (5).

3 Install plug (6) and washer (7).

4 Install two pipe plugs (8).



INSTALLATION:

NOTE

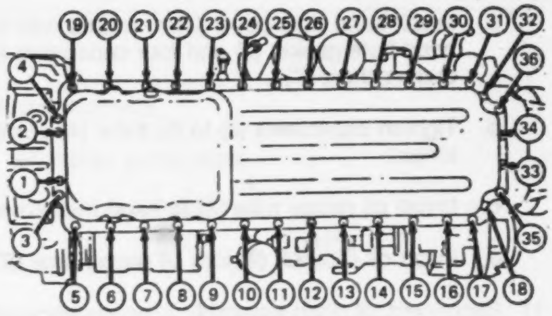
The silicone printed side of the gasket must be toward the oil pan.

1 Use a contact adhesive to attach new gasket to oil pan.

2 Install oil pan on cylinder block. Use your fingers to install and tighten all mounting capscrews.

3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE (CONT)

3 Use your fingers to install and tighten one of the 7/16-inch oil pan mounting capscrews on each side of oil pan, halfway between front and rear of oil pan.



4 Tighten the four 5/16-inch capscrews in the rear of the oil pan to 20 ft-lbs (25 N•m) torque in sequence shown.

5 Tighten 32 7/16-inch capscrews to 50 ft-lbs (70 N•m) torque in sequence shown.

NOTE

Use clean oil to lubricate the O-ring and the seal.

6 Install two new O-rings on oil pan lubricating oil suction tube and new rectangular sealing ring in lubricating oil transfer tube mounting flange.

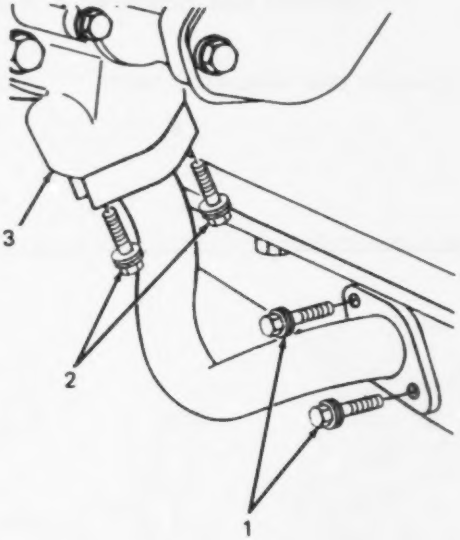
NOTE

The printed side of the mounting flange gasket on the oil transfer tube must be toward the flange.

7 Loosely assemble lubricating oil transfer tube, flanges, O-rings, gasket, and mounting capscrews, washers, and lockwashers to oil pan and lubricating oil pump.

8 Tighten two capscrews and lockwashers (1) at oil pan to 35 ft-lbs (45 N•m) torque.

9 Tighten two capscrews and washers (2) at lubricating oil pump (3) to 35 ft-lbs (45 N•m) torque.



3-38. OIL PAN AND OIL GAUGE BRACKET REPAIR/REPLACE (CONT)

10 Install oil gauge bracket as follows:

  a. Install hand hole cover (4) to engine with new hand hole gasket (5) and four capscrews (6) and washers (7).

  b. Tighten capscrews (6) to 35 ft-lbs (45 N·m) torque.

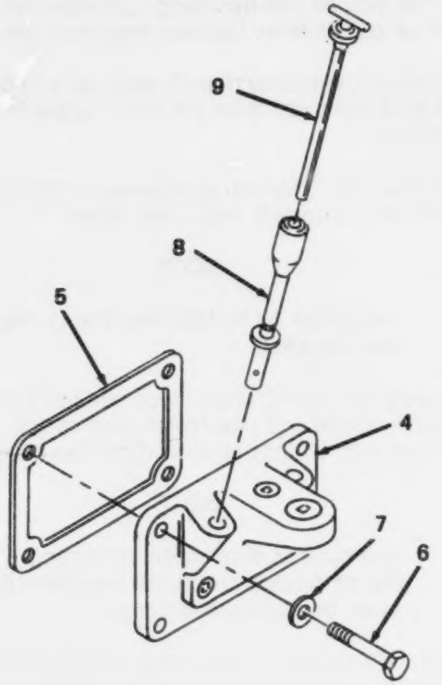
  c. Install oil gauge tube (8) to hand hole cover (4).

  d. Insert oil dipstick (9) into oil gauge tube (8).

11 Reconnect oil drain assembly in accordance with paragraph 2-55.

12 Reconnect oil drain tube assembly in accordance with paragraph 3-27.

13 Fill engine oil in accordance with paragraph 2-36.



3-39. GEAR COVER ASSEMBLY INSPECT/REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

Tools

- Magnet
- Drill (Item 2, Appendix B)
- Dial indicator (Item 5, Appendix B)
- Torque wrench (Item 2, Appendix B)
- Tool kit, general mechanics (Item 1, Appendix B)
- Mandrel (Item 30, Appendix B)
- Seal puller (Item 39, Appendix B)

Materials/Parts

- Emery cloth (Item 2, Appendix C)
- Crocus abrasive cloth (Item 1, Appendix C)
- Lubricating oil (Item 22, Appendix C)
- Crankshaft oil seal

Materials/Parts

- Suitable guide studs
- Accessory drive oil seal
- Soft cloth

Equipment Condition Reference	Condition Description
Paragraph 2-41	Alternator drive belt removed
Paragraph 3-30	Accessory drive pulley removed
Paragraph 2-48	Fan drive belts removed
Paragraph 2-50	Water pump drive belts removed

DISASSEMBLY:

1 Remove vibration damper (1) and pulley (2) as follows:

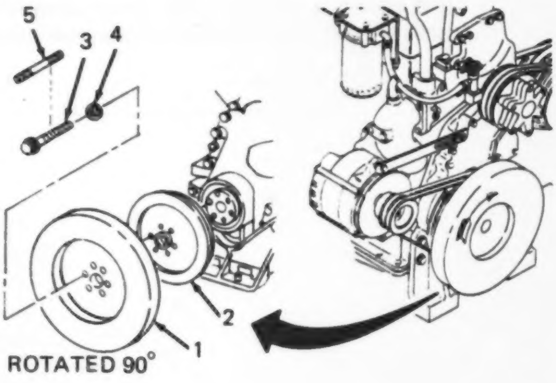
   a. Remove one capscrew (3) and washer (4) holding vibration damper (1) and pulley (2) to crankshaft, and install guide stud (5) in its place.

   CAUTION

   Do not use a hammer or screwdriver to remove a viscous damper. Those tools can cause damage to the damper.

   b. Remove five remaining capscrew (3) and washers (4) and slide vibration damper (1) and pulley (2) off guide stud (5).

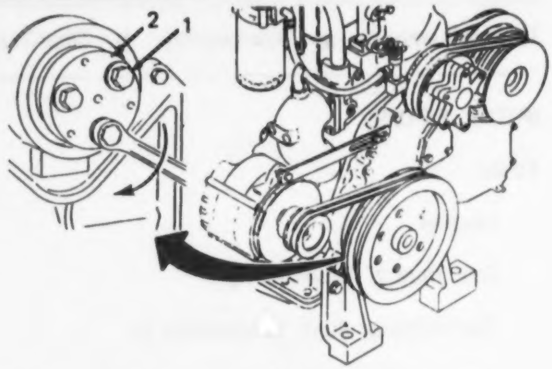
   c. Remove guide stud (5).



3-39. GEAR COVER ASSEMBLY INSPECT/REPAIR (CONT)

2 Remove crankshaft oil seal as follows:

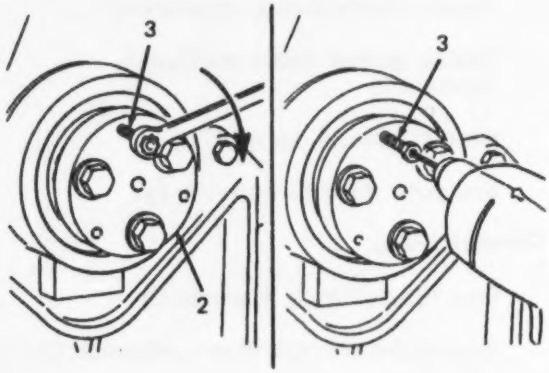
a. Use three crankshaft damper mounting capscrews (1) to secure top plate (2) of oil seal puller/installer to front of crankshaft.



b. Install drill pilot (3) in one of the 1/4-inch holes in top plate (2).

c. Insert No. 31 (0.120-inch) drill bit in drill pilot (3) and drill a hole through seal casing.

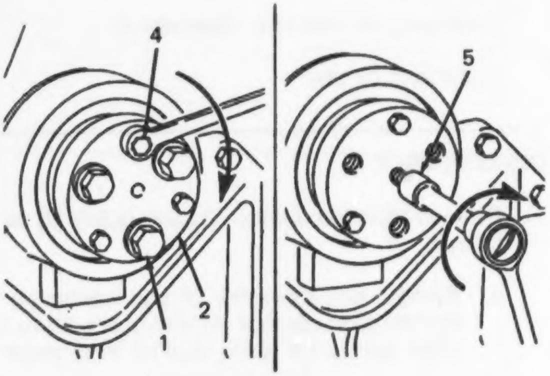
d. Remove drill pilot (3) and repeat the same procedure in two remaining holes in top plate (2).



e. Install three seal puller screws (4) in top plate (2).

f. Remove three crankshaft damper mounting capscrews (1) from top plate (2).

g. Install center puller screw (5) in top plate (2) and continue turning puller screw clockwise until oil seal is removed from the gear cover.

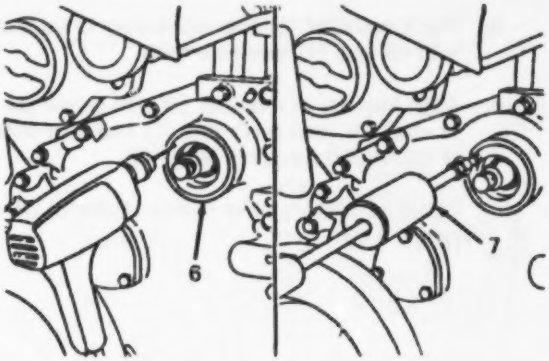


3-39. GEAR COVER ASSEMBLY INSPECT/REPAIR (CONT)

3 Remove accessory drive seal as follows:

a. Drill two 1/8-inch holes 180 degrees apart in accessory drive seal (6) casing, and install two No. 10 sheet metal screws in holes.

b. Use a slide hammer (7) or pry bar on sheet metal screws to remove seal (6).



CLEANING/INSPECTION:

1 Use a magnet to remove any shavings from seal bores, crankshaft, or accessory drive shaft.

2 Inspect seal bore for nicks, scratches, and sharp edges.

3 Use a 240 grit emery cloth dipped in clean lubricating oil to remove any minor defects.

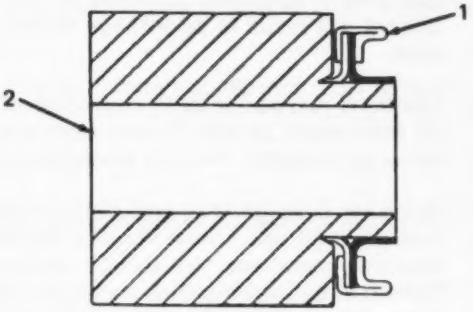
4 Use crocus cloth to remove any deposits from seal bore as a final polishing operation.

5 Clean shafts and bores with a clean cloth.

ASSEMBLY:

1 Install accessory drive oil seal as follows:

a. Install oil seal (1) on fuel pump drive oil seal mandrel (2) with closed or part number side facing mandrel.



NOTE

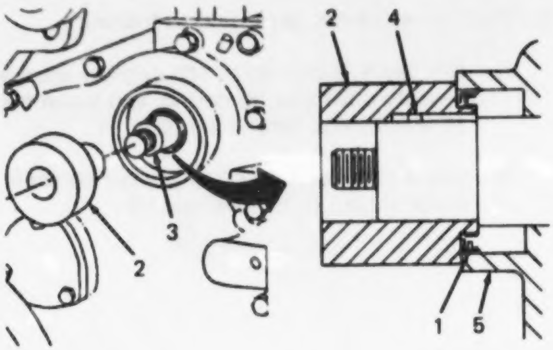
Do not use any kind of lubricant to install the seal. The oil seal must be installed with the lip of the seal and the seal wear area of the accessory drive pulley clean and dry. Use of lubricant will result in oil leakage at the seal.

3-39. GEAR COVER ASSEMBLY INSPECT/REPAIR (CONT)

b. Place mandrel (2) over accessory drive shaft (3) with oil seal (1) toward engine.

c. Align keyway in mandrel (2) with dowel pin (4) in shaft (3), and push seal (1) into seal bore until mandrel fits against ledge (5).

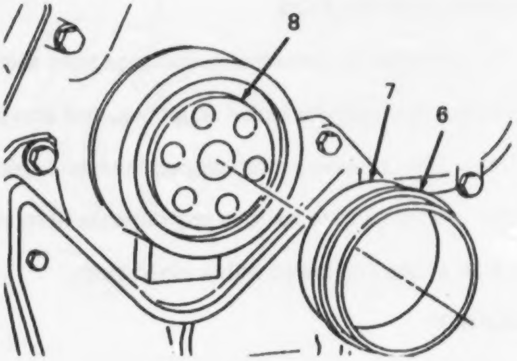
d. Install accessory drive pulley. Refer to paragraph 3-29.



2 Install crankshaft oil seal as follows:

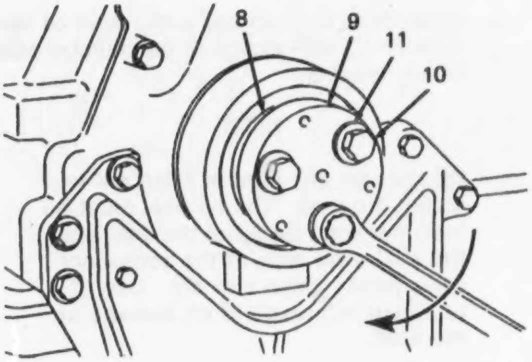
NOTE

LDL TFE (Lay-down Lip, Teflon) oil seals for service replacement have an assembly tool which protects the seal lip during shipment and installation. The LDL TFE oil seal must be installed with the lip of the seal and the crankshaft clean and dry. Do not use any kind of lubricant. The use of lubricant will result in oil leakage at the seal.



a. Use hand pressure to push crankshaft oil seal (6) from assembly tool (7) onto crankshaft (8) as far as possible. Remove assembly tool.

b. Install top plate (9) of oil seal puller/installer on crankshaft (8) using three vibration damper mounting capscrews (10) with flat washers (11). Tighten three capscrews alternately in 1/2 turn increments until top plate (9) seats against end of crankshaft (8).

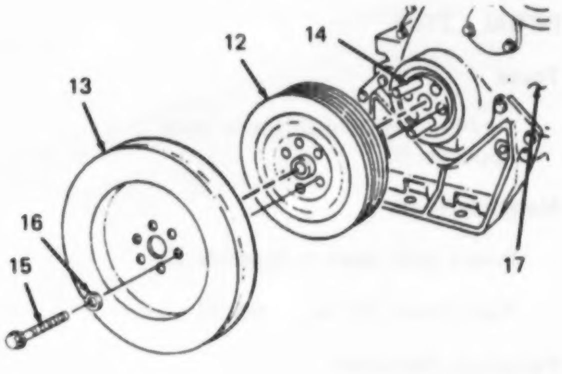


3-39. GEAR COVER ASSEMBLY INSPECT/REPAIR (CONT)

3 Install crankshaft pulley (12) and vibration damper (13) as follows:

a. Install two guide studs (14) in crankshaft nose.

b. Install pulley (12) and vibration damper (13) on guide studs (14).



NOTE

Make sure the mounting surfaces of the crankshaft nose, vibration damper and pulley are clean, dry and free from burrs.

c. Lubricate threads of capscrews (15) and face of washers (16) with oil.

d. Install four capscrews (15) and washers (16) hand tight.

e. Remove two guide studs (14) and replace with two capscrews (15) and washers (16).

f. Tighten six capscrews (15) to 190 ft-lbs (260 N•m) torque.

4 Check eccentricity of vibration damper (13) as follows:

a. Install dial indicator to gear cover (17) and set plunger on edge of vibration damper (13). Rotate crankshaft and record dial indicator movement.

b. Replace vibration damper if eccentricity exceeds 0.004 inch (0.10 mm) per 110 inch (25.4 mm) of damper diameter.

5 Check vibration damper (13) for wobble as follows:

a. Install dial indicator on gear cover (17) and set plunger on front surface of vibration damper (13).

b. Push crankshaft to front or rear.

c. Rotate crankshaft 360 degrees, maintaining axial position of crankshaft, and record total dial indicator motion.

d. Replace damper if wobble exceeds 0.007 inch (0.18 mm) per 1.0 inch (25.4 mm) of radius.

6 Install fan drive and water pump drive pulleys in accordance with paragraphs 2-48 and 2-50.

7 Install alternator drive belt in accordance with paragraph 2-41.

3-40. SKID REPAIR/REPLACE

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Emery cloth (Item 2, Appendix C)

Paint (Item 23, Appendix C)

Personnel Required

Two

Manual References

TM 9-237

Equipment Condition Reference	Condition Description
Paragraph 3-20	Engine assembly removed
Paragraph 2-33	Network cable removed
Paragraph 2-30	Field instrument layout removed
Paragraph 2-31	Conduit layout removed
Paragraph 2-32	Junction box removed
Paragraph 2-55	Oil drain assembly removed
Paragraph 2-22	Tank assembly removed
Paragraph 2-21	Feeding system removed
Paragraph 2-29	Cabinet enclosure removed
Paragraph 2-24	Storage box and cover removed
Paragraph 2-27	Batteries, battery box, and cables removed
Paragraph 2-20	Grounding assembly removed
Paragraph 2-56	Suction and discharge covers removed
Paragraph 3-8	Pump assembly removed

General Safety Instructions

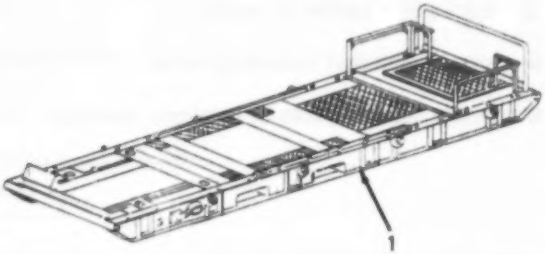
Well ventilated area for steam cleaning and welding procedures

3-40. SKID REPAIR/REPLACE (CONT)

REMOVAL:

1 In cases of localized damage to skid (1), remove components only to extent required to gain access to damaged area.

2 If skid (1) is bent or twisted so that frame straightening equipment is required, remove all attached components as listed in condition description.



CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean the skid and dry with compressed air.

2 Inspect the skid for major bending and twisting. If frame straightening equipment is required, contact general support maintenance.

3 If skid has no major bending and twisting, inspect for the following:

  a. dents and localized bending

  b. torn or gouged areas

3-40. SKID REPAIR/REPLACE (CONT)

c. rust spots and punctures

d. cracks in structure or welds

e. torn or distorted mounting holes

4 Straighten out any dents or localized bending.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, properly tinted lenses, an apron or jacket, and welders' boots are required to avoid injury to personnel.

5 Weld cracks in structure or welds and use patches to repair areas that are rusted through or punctured. Refer to TM 9-237.

WARNING

Grinding operations create airborne dust and particles. Respiratory and eye protection is required to avoid injury to personnel.

6 Grind smooth any gouges, tears, or repaired areas. Finish with emery cloth and repaint.

INSTALLATION:

1 Install engine assembly in accordance with paragraph 3-20.

2 Install pump assembly in accordance with paragraph 3-8.

3 Install grounding assembly in accordance with paragraph 2-20.

4 Install oil drain assembly in accordance with paragraph 2-55.

5 Install tank assembly in accordance with paragraph 2-22.

6 Install feeding system in accordance with paragraph 2-21.

7 Install storage box and cover in accordance with paragraph 2-24.

8 Install cabinet enclosure in accordance with paragraph 2-29.

9 Install battery box, batteries, and cables in accordance with paragraph 2-27.

3-40. SKID REPAIR/REPLACE (CONT)

10 Install junction box in accordance with paragraph 2-32.

11 Install conduit layout in accordance with paragraph 2-31.

12 Install field instrument layout in accordance with paragraph 2-30.

13 Install network cable in accordance with paragraph 2-33.

14 Install suction and discharge covers in accordance with paragraph 2-56.

15 Test run engine in accordance with paragraph 3-20.

CHAPTER 4
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

INTRODUCTION

This chapter contains the following frequently used maintenance information:

a. Troubleshooting

b. Maintenance procedures

The symptom index on page 4-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 4-4.

Section	Title	Page
I	Troubleshooting	4-1
II	Maintenance Procedures	4-4

Section I. TROUBLESHOOTING

4-1. TROUBLESHOOTING

a. Table 4-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of general support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections or corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of general support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to TM 5-4320-307-10. For troubleshooting procedures within the scope of unit maintenance, refer to table 2-2. For troubleshooting procedures within the scope of direct support maintenance, refer to table 3-1.

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4-2. SYMPTOM INDEX

Refer to the symptom index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the centrifugal pump unit. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine is hard to start	4-3
2	Engine consumes excessive lube oil (may produce blue smoke)	4-3
3	Engine produces excessive crankcase pressure	4-3
4	Engine has low oil pressure	4-3

Table 4-1. General Support Maintenance Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ENGINE IS HARD TO START

Step 1. Check for sticking or burned exhaust valves. Inspect valves.

Repair or replace faulty valves (para 4-12).

Step 2. Check for broken or worn piston rings. Inspect pistons and rings. Inspect cylinder head assembly.

Repair or replace pistons (para 4-16) and cylinder head assembly (para 4-12). Replace piston rings (para 4-16).

2. ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)

Step 1. Check for worn or broken double-chamfered rings. Inspect pistons and rings. Inspect cylinder head assembly.

Repair or replace faulty pistons (para 4-16) and cylinder head assembly (para 4-12). Replace piston rings (para 4-16).

Step 2. Check for scored cylinders or pistons. Inspect cylinders and pistons.

Repair or replace faulty cylinder head assembly (para 4-12 or 3-36) and piston (para 4-16).

Step 3. Check for loose piston pin circlips. Inspect piston pin circlips.

Replace a loose piston pin circlip (para 4-16).

Step 4. Check for piston and connecting rod alinement. Inspect pistons and connecting rods. Check crankshaft thrust surfaces for wear or grooving.

Replace a faulty piston (para 4-16) or connecting rod (para 4-16). If necessary, replace crankshaft (4-17).

3. ENGINE PRODUCES EXCESSIVE CRANKCASE PRESSURE

Step 1. Check for worn piston rings, a hole or crack in a piston crown, or excessive exhaust back pressure.

Replace worn or damaged parts (para 4-16).

4. ENGINE HAS LOW OIL PRESSURE

Step 1. Check for excessive wear on crankshaft bearing journals or main bearings. Inspect crankshaft and main bearings.

Replace faulty crankshaft or main bearings, if necessary (para 4-17).

Section II. MAINTENANCE PROCEDURES

INDEX

	Para
Camshaft Assembly Inspect/Repair/Replace	4-15
Connecting Rod and Piston Assembly Replace/Repair	4-16
Crankshaft Assembly Replace/Repair	4-17
Cylinder Block Inspect/Repair/Replace	4-18
Cylinder Head Assembly Repair	4-12
Flywheel and Flywheel Housing Repair (Rear Oil Seal)	4-13
Fuel Pump Assembly Repair/Calibrate	4-9
Gear Cover Assembly Repair/Replace	4-14
Injector Repair	4-11
Lube Oil Pump Assembly Repair	4-10
Pump Assembly Mechanical Seal Repair	4-4
Pump Assembly Shaft Inspect/Test/Repair	4-5
Skid Repair	4-19
Speed Increaser Repair	4-6
Turbocharger Repair (HC3-16)	4-7
Turbocharger Repair (T-18A)	4-8

4-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following.

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and START/STOP switch set at STOP. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix D to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in the procedure. Standard torque values given in Appendix D are determined by thread size.

4-4. PUMP ASSEMBLY MECHANICAL SEAL REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Materials/Parts

Packings

Seal rings

Dry cleaning solvent (Item 30, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 3-11	Mechanical seal removed

General Safety Instructions

Well ventilated area required during cleaning

DISASSEMBLY:

NOTE

Disassembly of the stationary seal rings, rotary seal rings, and packings is normally enough to refurbish the mechanical seal. Seal faces are often reconditionable by lapping.

Each time the mechanical seal is replaced or disassembled, replace packings.

4-4. PUMP ASSEMBLY MECHANICAL SEAL REPAIR (CONT)

1 Remove six setscrews (1) and remove shaft collar (2).

2 Draw shaft sleeve (3) from seal plate (4).

3 Remove shaft sleeve packing (5).

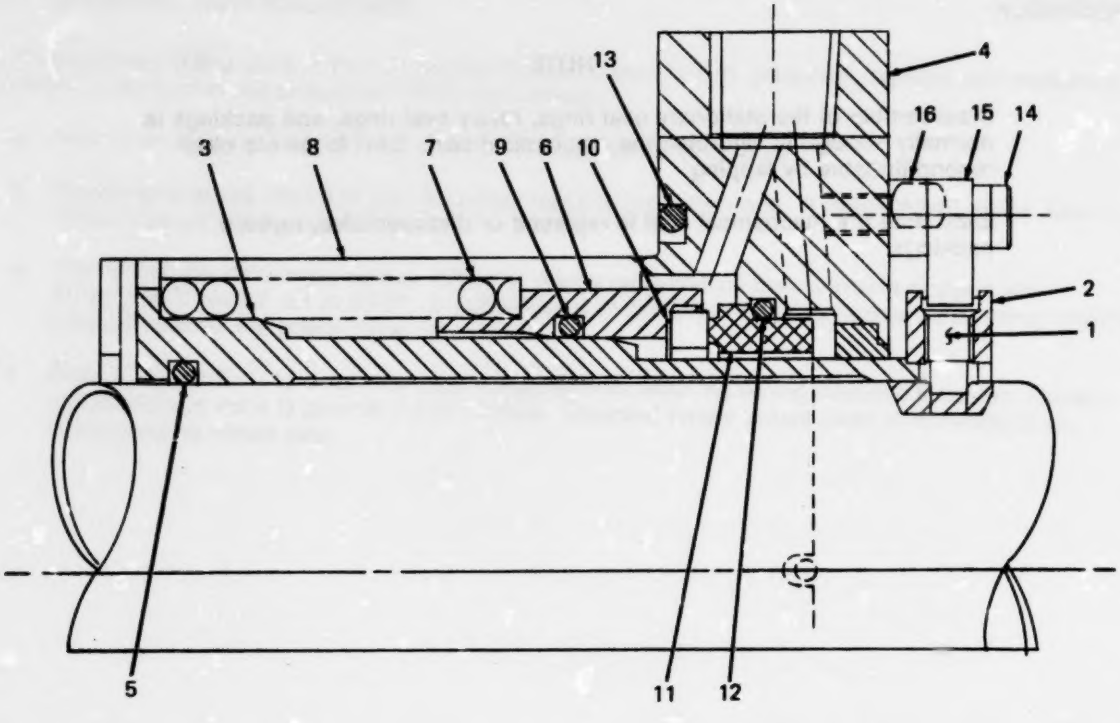
4 Twist rotary seal ring assembly (6) and spring (7) from shaft sleeve (3).

5 Separate rotary seal ring (6) from rotary seal ring carrier (8). Remove rotary seal ring packing (9). Do not remove seal face protection washer (10).

6 Push out stationary seal ring (11) and remove stationary seal ring packing (12).

7 Remove seal plate packing (13) from seal plate (4).

8 Remove screw (14), excentric washer (15), and spacer (16) from seal plate (4).



4-4. PUMP ASSEMBLY MECHANICAL SEAL REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean metal components with dry cleaning solvent and dry with compressed air.

2 Inspect tolerances on associated parts as follows:

a. Shaft diameter in seal area: nominal size 0.00/-0.002 inch (0.00/-0.05 mm)

b. Shaft finish in seal area: 0.8 micrometers center line average

c. Shaft end play: 0.004 inch (0.1 mm maximum)

d. Shaft run-out in seal area:

Size	0.984 in. (25 mm)	1.968 in. (50 mm)	2.953 in. (75 mm)	3.937 in. (100 mm)
Tolerance	0.001 in. (0.03 mm)	0.002 in. (0.05 mm)	0.003 in. (0.08 mm)	0.004 in. (0.10 mm)

e. Squareness of shaft to staffing box face:

Size	0.984 in. (25 mm)	1.968 in. (50 mm)	2.953 in. (75 mm)	3.937 in. (100 mm)
Tolerance	0.002 in. (0.05 mm)	0.002 in. (0.05 mm)	0.003 in. (0.08 mm)	0.004 in. (0.10 mm)

f. Concentricities of sleeve and box bore:

Size	0.984 in. (25 mm)	1.968 in. (50 mm)	2.953 in. (75 mm)	3.937 in. (100 mm)
Tolerance	0.002 in. (0.05 mm)	0.003 in. (0.08 mm)	0.004 in. (0.10 mm)	0.005 in. (0.13 mm)

3 Repair as follows:

a. Replace all packings and gaskets each time mechanical seals are all disassembled.

b. Recondition seal faces if facilities are available.

4-4. PUMP ASSEMBLY MECHANICAL SEAL REPAIR (CONT)

c. Metal components may be lightly polished but must not be re-machined.

d. Polish shaft sleeve score marks. No more than 0.0004 inch (0.01 mm) should be taken from any diameter.

e. Check the condition of seal face protection washer and replace if necessary.

ASSEMBLY:

1 Install spacer (1), excentric washer (2), and screw (3) into seal plate (4) loosly. Insure seal face protection washer (5) is fitted.

2 Insure groove is clean and fits new rotary seal ring packing (6).

3 Fit rotary seal ring (7) into rotary seal ring carrier (8).

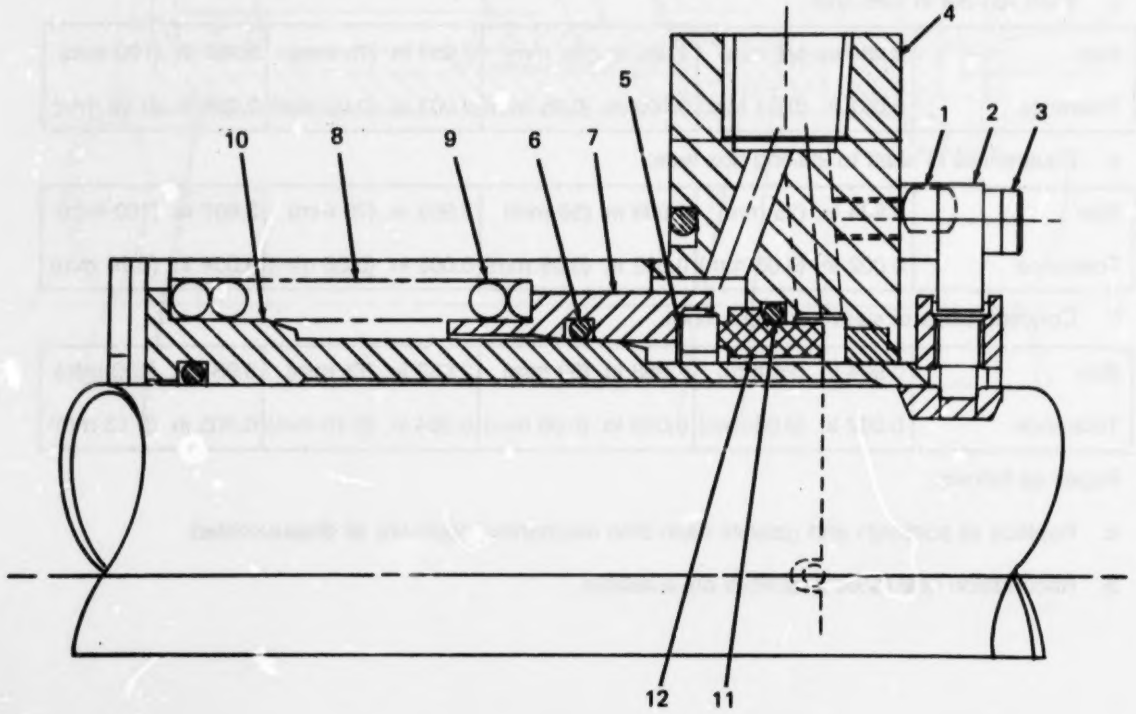
4 Fit spring (9) to rotary seal ring assembly (7).

5 Fit rotary seal ring (7) and spring assembly (9) to shaft sleeve (10) taking care when sliding seal ring packing (6) over discontinuities.

6 Fit new stationary seal ring packing (11) to stationary seal ring (12).

7 Align slot in stationary sealing (12) with anti-rotation pin and press in as far as possible by hand.

8 Protect seal face with paper or fabric and with a flat plate for even loading drive stationary seal ring home with steady hand pressure.



4-4. PUMPING ASSEMBLY MECHANICAL SEAL REPAIR (CONT)

9 Place shaft sleeve packing (13) in position on shaft sleeve (10).

10 Place seal plate packing (14) in position on seal plate (15).

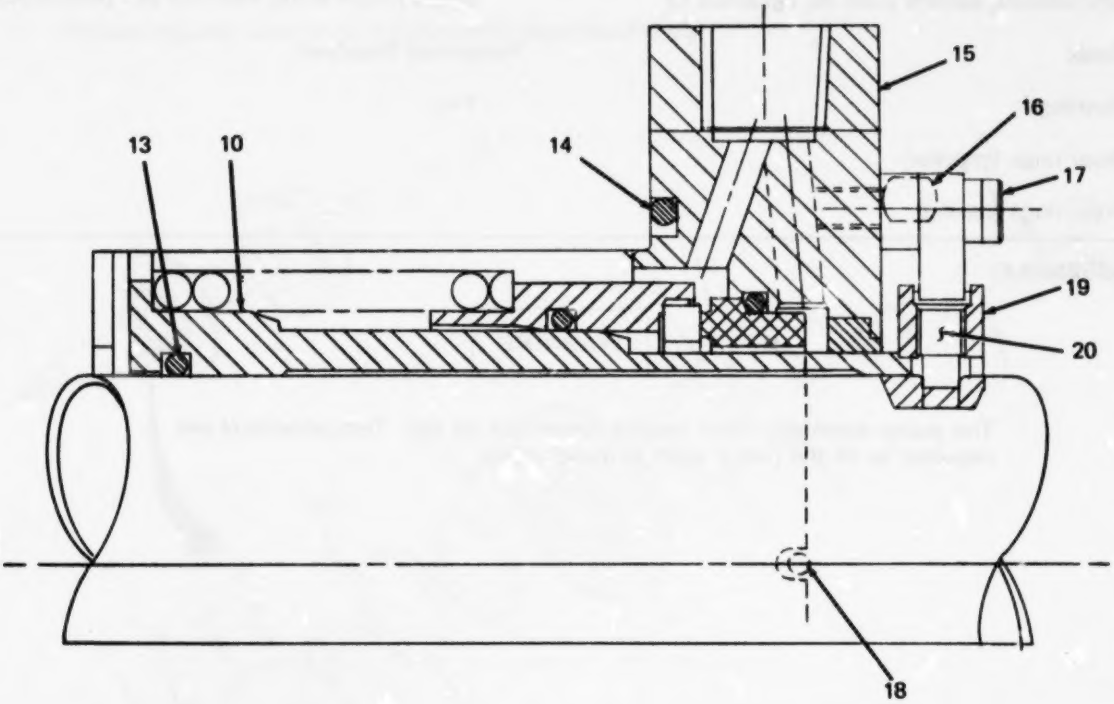
11 Insert shaft sleeve (10) through the seal plate (15). The end of shaft sleeve protrudes through the atmosphere side of seal plate (15).

12 Insure setting washer (16) is locked with setscrews (17).

NOTE

Ensure setscrews (18) are backed off and do not protrude into bore.

13 Place shaft collar (19) in position and secure on shaft sleeve (10) with six setscrews (20).



4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Testing d. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Oven

Dial indicator (Item 5, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Seals

Bushings

Wear rings (impeller)

Wear rings (casing)

Equipment Condition

Reference	**Condition Description**
Paragraph 3-10	Shaft removed

General Safety Instructions

Well ventilated area

Insure proper lifting methods and procedures

Personnel Required

Two

DISASSEMBLY:

WARNING

The pump assembly shaft weighs more than 50 lbs. Two personnel are required to lift the pump shaft to avoid injury.

4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPAIR (CONT)

1 Remove first stage impeller as follows:

a. Remove pin (1) and remove seal bushing (2) from shaft (3).

b. Remove split ring (4).

c. Remove key (5).

d. Remove first stage impeller (6).

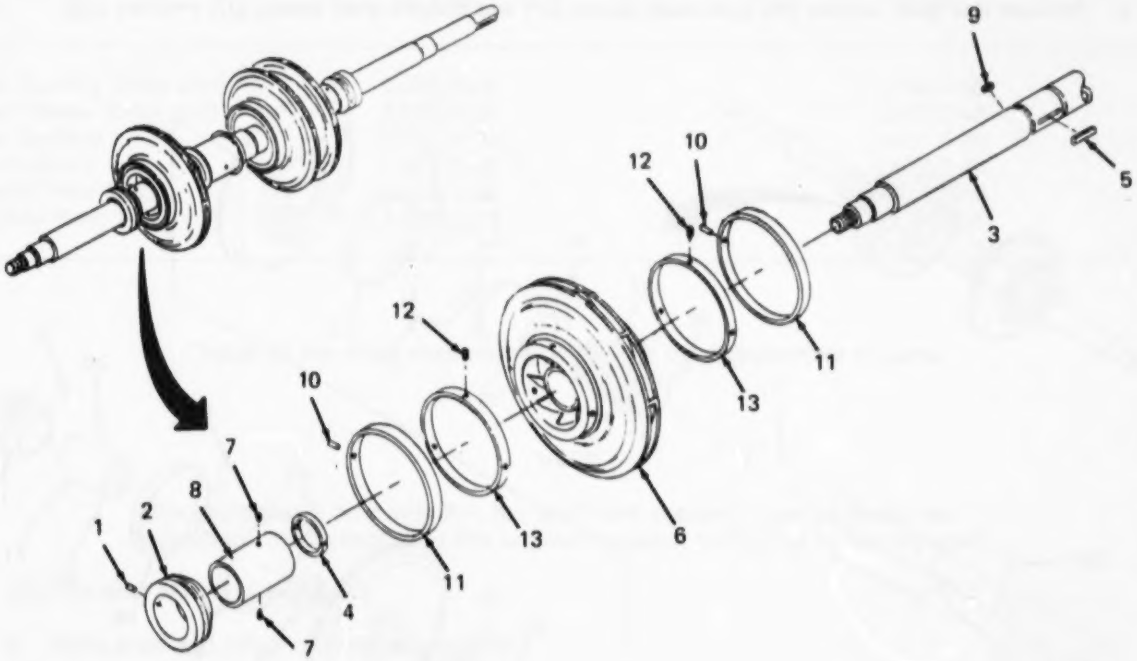
e. Remove two grub screws (7) and remove shaft sleeve (8) and key (9).

f. Remove pins (10) from two casing wear rings (11).

g. Remove casing wear rings (11) from impeller (6).

h. Remove grub screws (12) from two first stage impeller wear rings (13).

i. Remove impeller wear rings (13) from first stage impeller (6).



4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE (CONT)

2 Remove second and third stage impeller as follows:

a. Remove pin (14) and remove seal bushing (15) from shaft (3).

b. Remove split ring (16), key (17), and second stage impeller (18).

c. Remove diaphragm (19).

d. Remove two grub screws (20) and remove shaft sleeve (21) and key (22).

e. Remove pins (23) from casing wear ring (24) and remove wear ring (24) from impeller (18).

f. Remove grub screws (25) from second stage impeller wear ring (26).

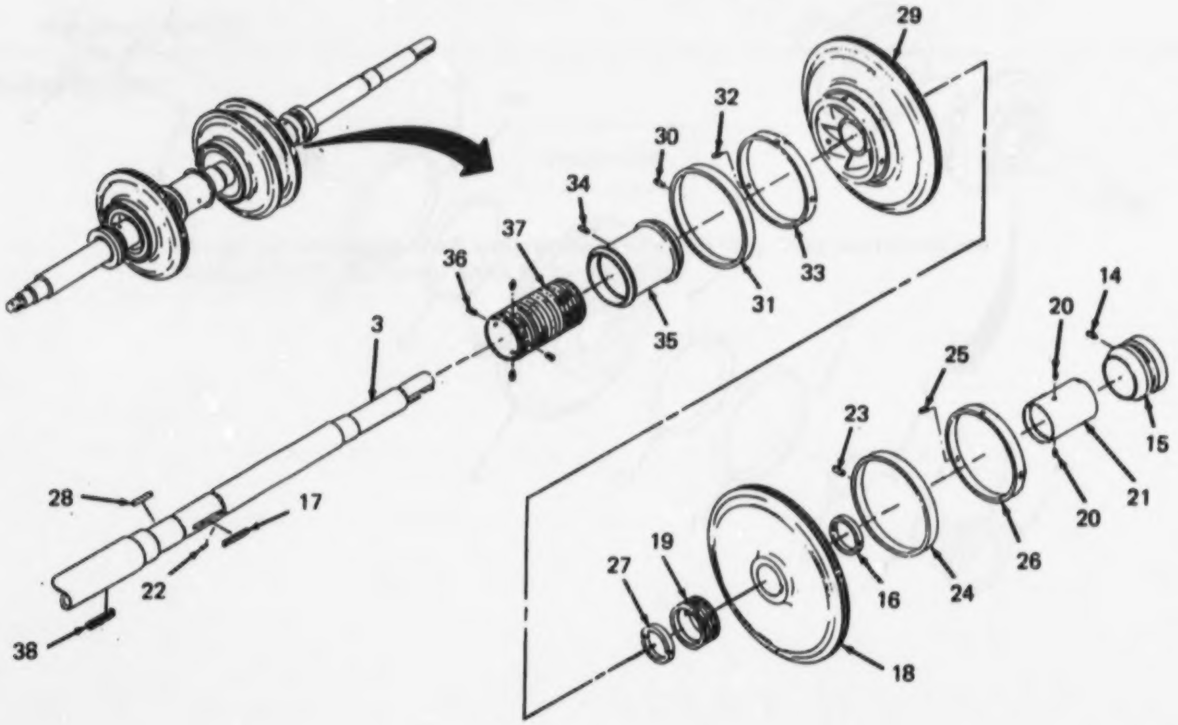
g. Remove split ring (27), key (28), and third stage impeller (29).

h. Remove pins (30) from casing wear ring (31) and remove from impeller (29).

i. Remove grub screws (32) from third stage impeller wear ring (33) and remove from impeller (29).

j. Remove pin (34) from seal bushing (35) and remove from shaft (3).

k. Remove four grub screws (36) from shaft sleeve (37) and remove shaft sleeve (37) and key (38).



CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Steam clean shaft assembly and dry with compressed air.

2 Check the radial tolerances between the following stationary and rotating items:

Item	Minimum Allowable Clearance In/MM	Recommended Maximum Wear Clearance In/MM
Seal Bushing (drive end)	0.009/0.23	0.018/0.46
Shaft Sleeve (drive end)	0.009/0.23	0.018/0.46
Seal Bushing	0.015/0.40	0.031/0.80
Shaft Sleeve	0.015/0.40	0.031/0.80
Casing Wear Rings	0.009/0.23	0.018/0.46
Impeller Wear Rings	0.009/0.23	0.018/0.46

NOTE

Repair of the shaft assembly is limited to the replacement of parts.

TEST:

NOTE

After replacing a new impeller, the shaft and impeller must be tested for balancing. When replacing the original impeller, balancing is not required.

1 Balance shaft assembly as follows:

a. Place shaft and rotors on balancing machine.

b. Connect shaft to balancing machine.

c. Start balancing machine and slowly increase speed to 650 rpm.

d. The maximum allowable unbalance shall be less than 0.024 lbs (11 grams) in each correction plane.

4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE (CONT)

WARNING

Grinding operations create airborne dust and particles. Respiratory and eye protection is required to avoid injury to personnel.

e. The recorded unbalance can be reduced by grinding material from sides of rotors.

NOTE

Do not reduce thickness of rotors more than 0.200 inch (5 mm).

Before reassembling the shaft, test the concentricity of the working points.

2 Test the concentricity as follows:

a. Place the following components on the shaft: shaft sleeves, impeller wear rings, and spacer.

b. Place shaft assembly along with components on two pairs of rollers. Revolve the assembly 360° while checking the concentricity with a dial indicator.

c. Concentricity on shaft sleeves, impeller wear rings, and spacer shall not exceed 0.003 inch (0.08 mm).

ASSEMBLY:

WARNING

The pump assembly shaft weighs more than 50 lbs. Two personnel are required to lift the pump shaft to avoid injury.

4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE (CONT)

1 Assemble the second and third stage impeller as follows:

a. Position shaft sleeve (1) on shaft (2), insert key (3), and secure with four grub screws (4).

b. Position seal bushing (5) on shaft (2) and insert pin (6).

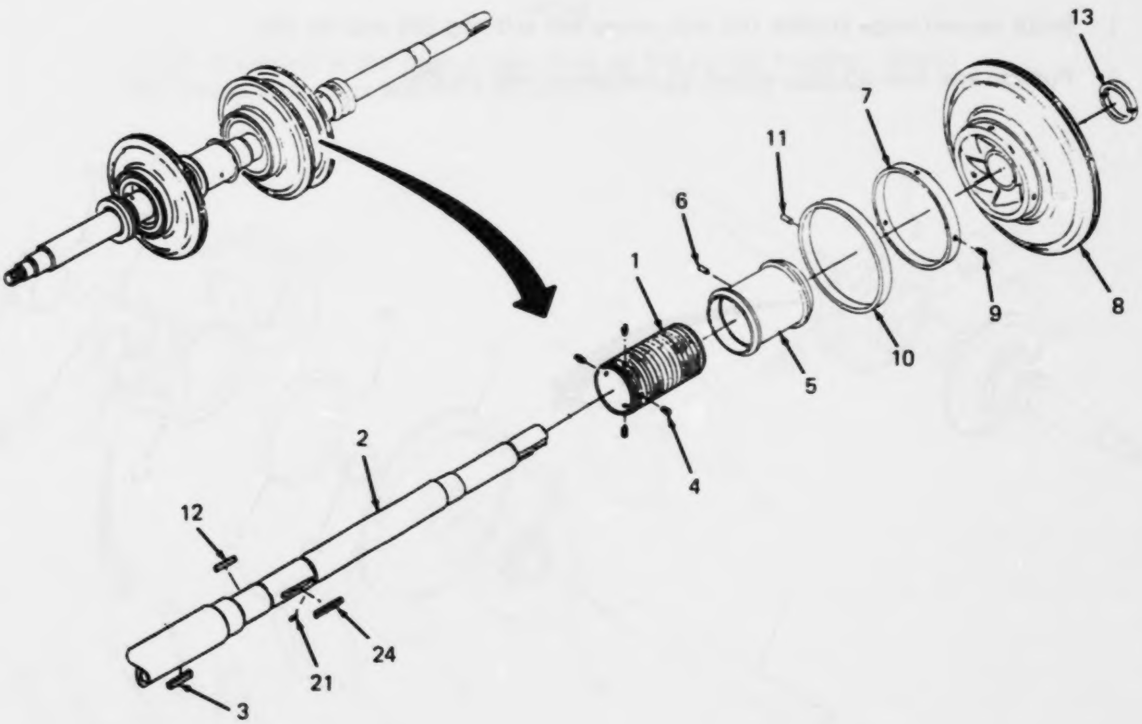
c. Heat impeller wear ring (7) to a temperature of approximately 662°F (350°C). Install wear ring (7) onto impeller (8) and secure with grub screws (9).

d. Install casing wear ring (10) and secure with pins (11).

NOTE

Split rings must be adjusted. Allow 0.039 inch (1 mm) machining allowance.

e. Install third stage impeller (8) and secure with key (12) and split ring (13). Adjust split rings as required.



4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE (CONT)

WARNING

Wear protective gloves when handling parts that have been heated, to prevent personal injury.

f. Heat impeller wear ring (14) to a temperature of approximately 662°F (350°C). Install wear ring (14) onto impeller (15) and secure with grub screws (16).

g. Install casing wear rings (17) and secure with pins (18).

h. Position shaft sleeve (19) on shaft (2) and secure with two grub screws (20) and key (21).

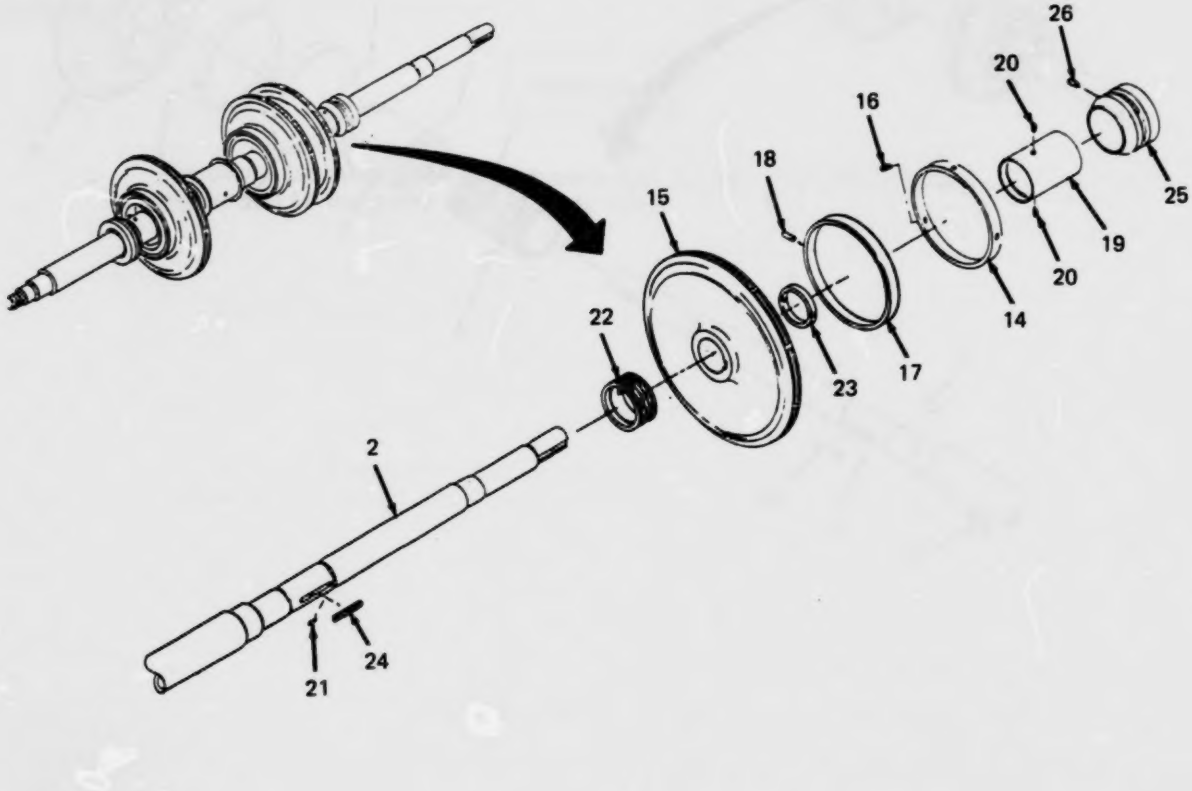
i. Install diaphragm (22).

NOTE

Split rings must be adjusted. Allow 0.039 inch (1 mm) machining allowance.

j. Install second stage impeller (15) and secure with split ring (23) and key (24).

k. Position seal bushing (25) on shaft (2) and secure with pin (26).



4-5. PUMP ASSEMBLY SHAFT INSPECT/TEST/REPLACE (CONT)

2 Assemble the first stage impeller as follows:

a. Heat two impeller wear rings (27) to a temperature of approximately 662°F (350°C). Install wear ring (27) onto impeller (28) and secure with grub screws (29).

b. Install two casing wear rings (30) on impeller (28) and secure with pins (31).

c. Install shaft sleeve (32) on shaft (2) and secure with two grub screws (33) and key (34).

NOTE

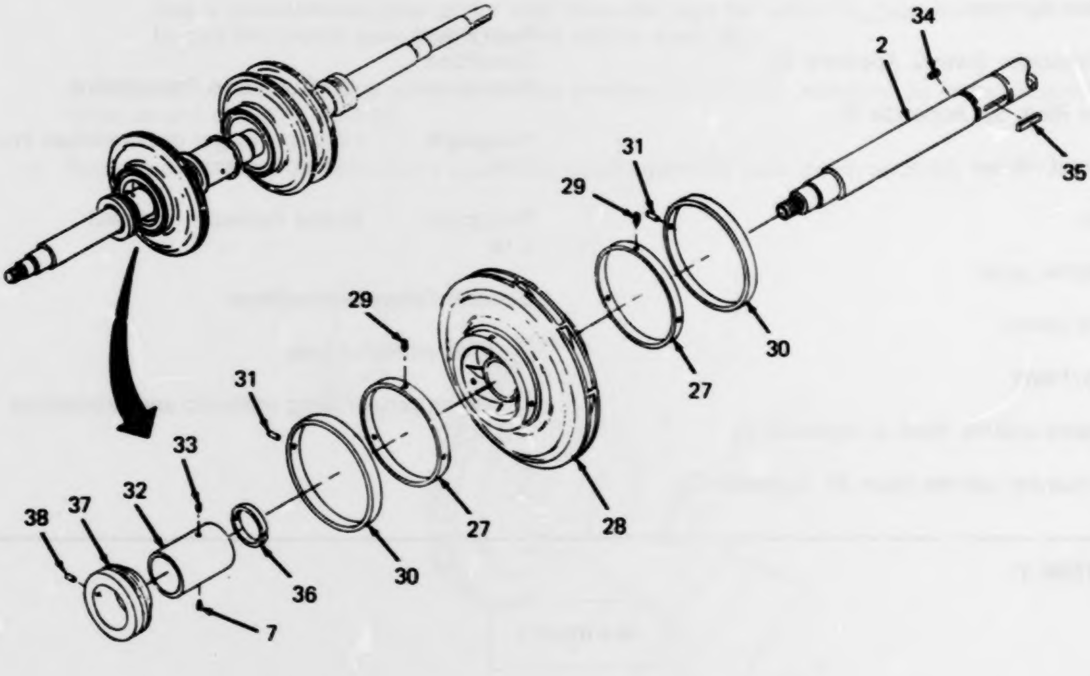
Split rings must be adjusted. Allow 0.039 inch (1 mm) machining allowance.

d. Install first stage impeller (28) on shaft (2) and secure with key (35) and split ring (36). Adjust split rings as required.

e. Install seal bushing (37) on shaft (2) and secure with pin (38).

NOTE

Check the truing of the casing wear rings on the casing housing. Adjust the casing wear rings and the seal bushing in the casing housing.



4-6. SPEED INCREASER REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Suitable lifting device

Lifting bail T-20209 (Item 26, Appendix B)

Wear sleeve driver (Item 19, Appendix B)

Wear sleeve driver (Item 18, Appendix B)

Drill (Item 2, Appendix B)

Slide hammer (Item 2, Appendix B)

Torque wrench (Item 2, Appendix B)

Rubber hammer

Dial indicator (Item 5, Appendix B)

Puller (Item 32, Appendix B)

Tap and die set

Press

Guillotine puller

Porter power

Materials/Parts

Adhesive sealant (Item 3, Appendix C)

Dry cleaning solvent (Item 30, Appendix C)

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Sealant M-2828 (Item 4, Appendix C)

Lockwasher

Cotter pins

Oil seals

Gaskets

O-rings

Snap rings

Suitable blocks

Equipment Condition Reference	Condition Description
Paragraph 2-34	Heat exchanger disconnected from speed increaser
Paragraph 3-18	Speed increaser removed

General Safety Instructions

Well ventilated area

Insure proper lifting methods and procedures

DISASSEMBLY:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

4-6. SPEED INCREASER REPAIR (CONT)

WARNING

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting bail assembly, slipping slings, or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Support speed increaser on a work bench with wooden blocks. Position clutch end facing upward.

2 Disassemble the speed increaser as follows:

a. Remove jam nut (1) and lockwasher (2) from hose fitting (3) in clutch housing (4). Push fitting (3) and hose (5) into clutch housing.

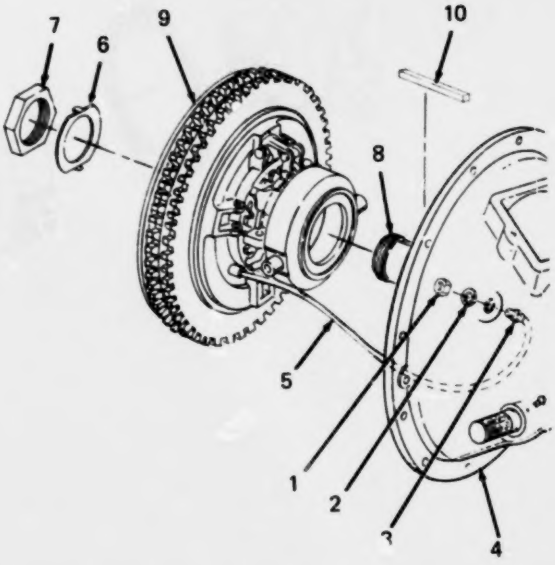
b. Straighten bent portion of hub nut lockwasher (6) from hub nut (7). Remove hub nut (7) and lockwasher (6) from clutch shaft (8). Discard hub nut lockwasher (6).

NOTE

Use a conventional gear puller with threaded legs for 5/8-11 tapped holes to pull the clutch assembly from the clutch shaft (8).

c. Install puller so threaded legs screw into holes provided in hub and backplate (9) and jack screw exerts force on end of clutch shaft (8).

d. Remove shaft key (10) and remove puller and clutch assembly from clutch shaft (8).



4-6. SPEED INCREASER REPAIR (CONT)

NOTE

Position the clutch assembly on a bench with the sleeve collar and hose assembly (5) facing upward.

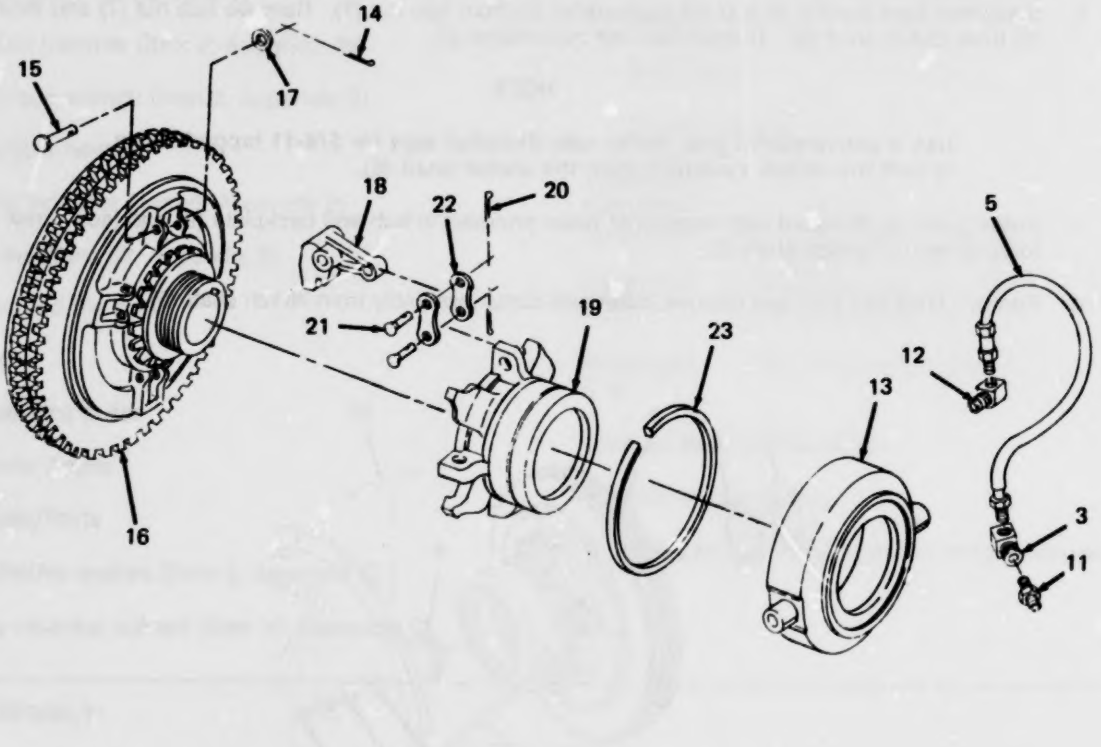
e. **Remove hydraulic grease fitting (11) from hose fitting (3) and remove hose fitting (3) from hose (5).**

f. **Remove hose (5) from fitting (12) and remove fitting (12) from sleeve collar assembly (13).**

g. **Straighten and remove four cotter pins (14) from lever pins (15). Remove four lever pins (15) from levers and floating plate (16). Remove two spring washers (17) at each lever location and remove levers (18), sliding sleeve (19), and sleeve collar (13) from floating plate (16) and adjusting ring assembly.**

h. **Straighten and remove eight cotter pins (20) from lever link pins (21). Remove lever link pins (21), lever links (22), and lever (18) from sliding sleeve assembly (19).**

i. **Remove snap ring (23) and sleeve collar (13).**



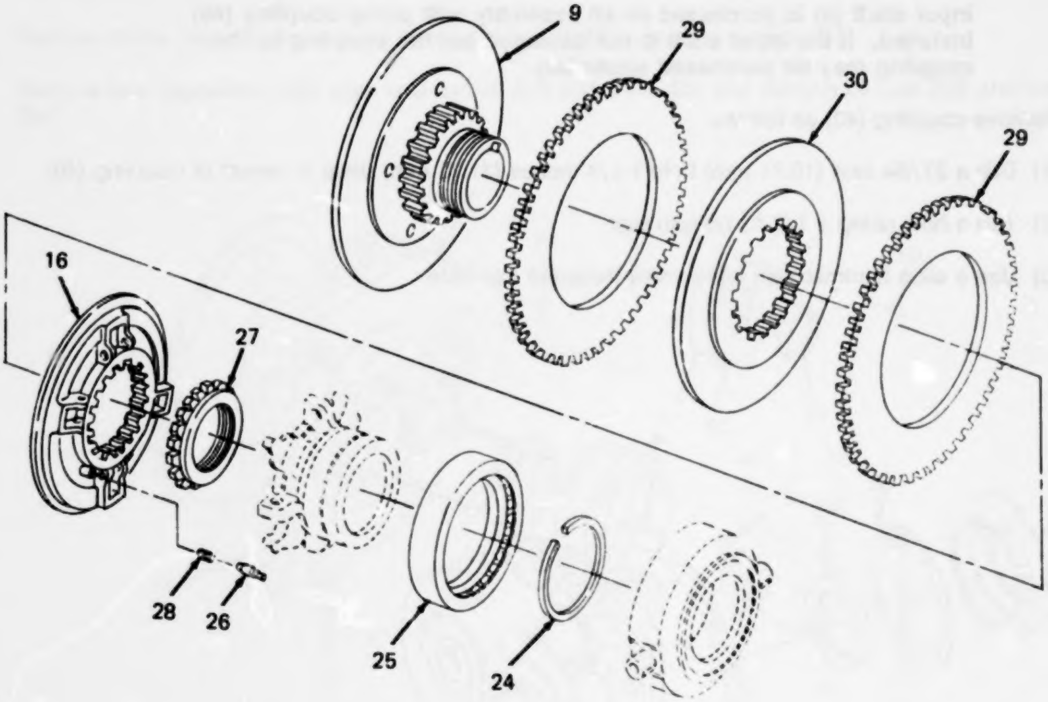
4-6. SPEED INCREASER REPAIR (CONT)

j. Remove snap ring (24) and ball bearing (25).

k. Depress adjusting lock pin (26) with a screwdriver and unscrew adjusting ring (27), removing it from hub of backplate (9).

l. Remove adjusting lock pin (26) and spring (28) from floating plate (16).

m. Remove floating plate (16), driving plates (29) and center plate (30).



4-6. SPEED INCREASER REPAIR (CONT)

n. Remove capscrews (31), bearing carrier (32), gasket (33), and oil seal (34).

o. Remove two round head machine screws (35) and remove instruction cover plate (36) from housing (4).

p. Remove two round head machine screws (37) and remove bottom cover plate (38) from housing (4).

q. Remove two hydraulic (grease) fittings (39) from housing (4).

NOTE

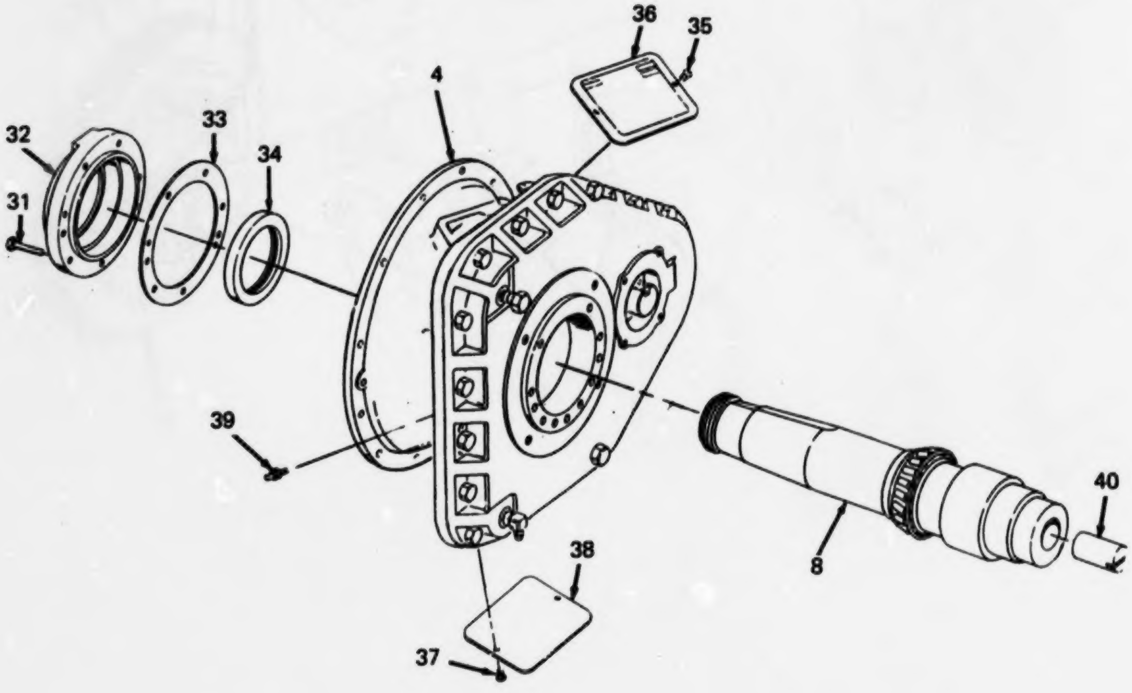
Input shaft (8) is purchased as an assembly with pump coupling (40) installed. If the input shaft is not damaged but the coupling is, the coupling may be purchased separately.

r. Remove coupling (40) as follows:

(1) Drill a 27/64 inch (10.71 mm) hole 1-1/4 inches (31.75 mm) deep in center of coupling (40).

(2) Tap a hole using a 1/2-13 bottom tap.

(3) Use a slide hammer with attachment threaded into hole.



4-6. SPEED INCREASER REPAIR (CONT)

3 Disassemble gear box assembly as follows:

a. Support unit with output end up.

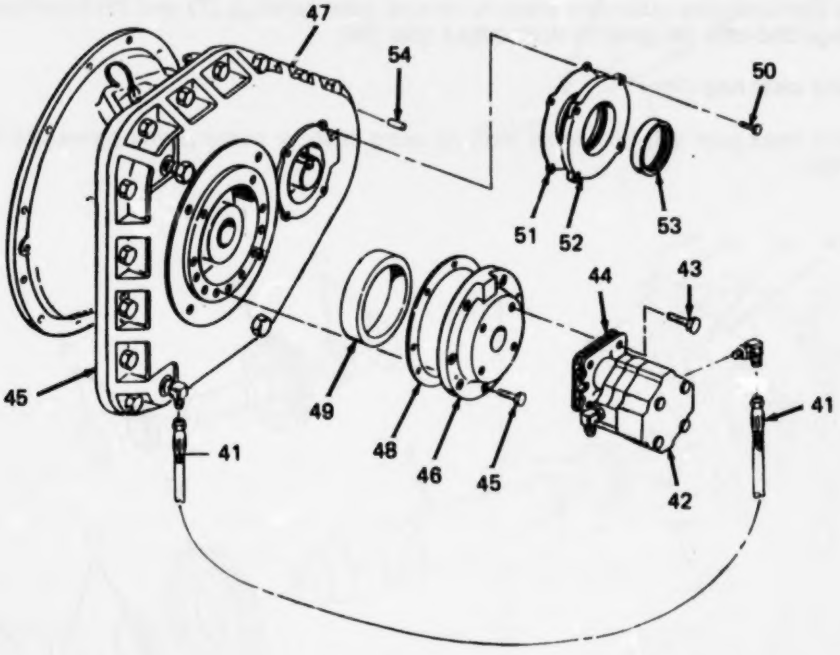
b. Remove hose assembly (41) between pump (42) and sump.

c. Remove four screws (43) and remove pump (42) and gasket (44).

d. Remove seven capscrews (45) and use two capscrews as pushers to remove bearing carrier (46) from rear housing (47).

e. Remove shims (48). Remove roller bearing race (49) from bearing carrier (46).

f. Remove four capscrews (50) from seal carrier (51) and shim (52) and remove oil seal (53) and dowel pin (54).



4-6. SPEED INCREASER REPAIR (CONT)

h. Remove 19 capscrews (55) from rear housing (47).

i. Remove rear housing (47) and gasket (56).

j. Remove input shaft (8) with input gear (57).

k. Remove output gear assembly (58).

l. Remove two capscrews (59), lockwashers (60), and oil dam (61).

m. Remove nut (62) and remove two screws (63), lockwashers (64), and tube support bracket (65).

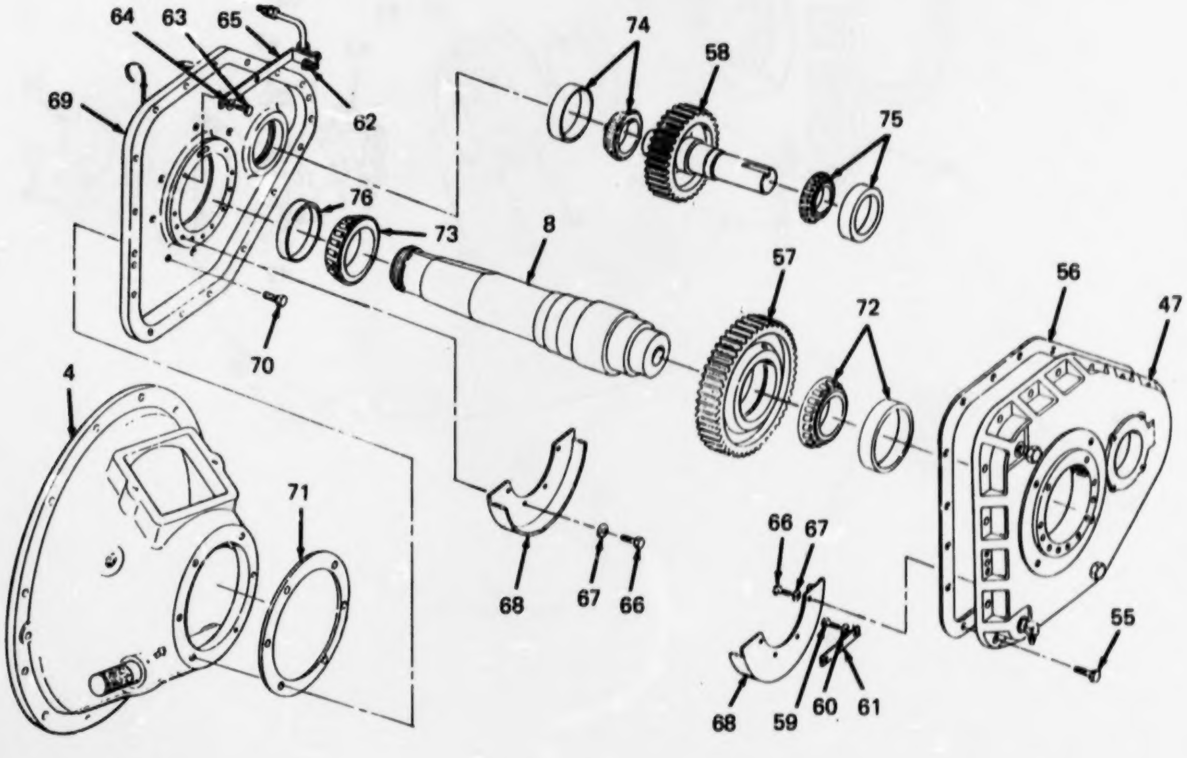
n. Remove four capscrews (66), lockwashers (67), and baffle (68) from rear gear housing (47) and front gear housing (69).

o. Remove eight screws (70) and remove front gear housing (69) from housing (4). Remove gasket (71).

p. Use a guillotine-type puller and press to remove roller bearings (72 and 73) from input shaft (8), and bearings and race (74 and 75) from output gear (58).

q. Replace wear ring (76).

r. Remove input gear (57) from input shaft (8) using puller or porter power connected to threaded hole in gear (57).



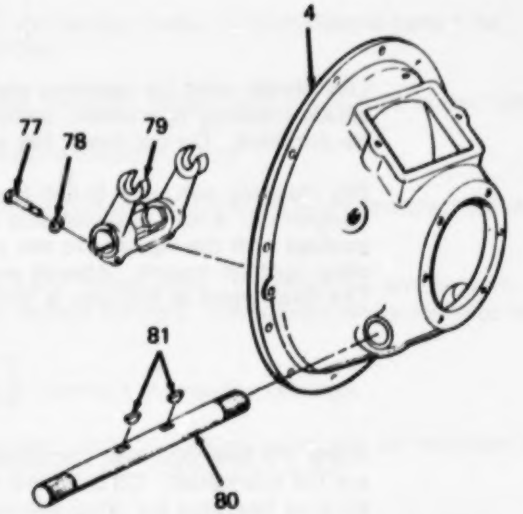
4-6. SPEED INCREASER REPAIR (CONT)

NOTE

If operating hand lever has not been removed, remove at this time.

s. Remove two screws (77) and lockwashers (78) from throw out yoke (79).

t. Remove operating shaft (80) and keys (81) from housing (4).



4-6. SPEED INCREASER REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

CAUTION

Never dry bearings with compressed air. Do not spin bearings while they are not lubricated. Oil bearings with engine oil immediately after cleaning. Be sure bearings are oiled before inspection.

NOTE

Do not remove grease in which new bearings are packed.

1 Clean speed increaser and components as follows:

   a. Using dry cleaning solvent or steam clean all parts..

   b. Parts cleaned with dry cleaning solvent or steam must be dried and oiled immediately.

2 Inspect and repair speed increaser and components as follows:

   a. Examine all parts carefully for grit, dirt, and abrasives and reclean them if necessary.

   b. Replace cast parts or housings that are cracked.

   c. Inspect bores for wear, grooves, scratches, and dirt. Remove burrs and scratches with crocus cloth or soft stone. Replace parts that are deeply grooved or scratched.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protection equipment.

4-6. SPEED INCREASER REPAIR (CONT)

d. Inspect oil passages for obstructions. If an obstruction is found, remove it with compressed air or by working a wire back and forth through the passage and flushing it with dry cleaning solvent.

e. Inspect machined surfaces for burrs, scratches, nicks, and foreign matter. If such defects cannot be removed with crocus cloth or a soft stone, replace the part.

f. Inspect threaded openings for damaged threads. Chase damaged threads with a tap of the correct size.

g. Inspect studs for damaged threads and looseness. Replace defective studs.

h. Inspect dowel pins for wear or damage. Replace defective dowels. This applies where matched set of parts is not involved.

i. Inspect dowel pin holes for wear due to movement between mating parts. If a dowel pin hole is worn, rebore and sleeve the hole when possible. Otherwise, replace the part. This applies where matched set of parts is not involved.

j. Inspect bearings for roughness of rotation. Replace the bearing if the rotation is rough.

k. Inspect bearings for corrosion, scored, scratched, cracked, pitted or chipped races, and for indication of excessive wear of balls or rollers. If one of these defects is found, replace the bearing.

l. Inspect bearing bores and shafts for grooved, burred, or galled conditions that would indicate that the bearing has been turning in its housing, or on its shaft. If damage cannot be repaired with crocus cloth, replace the part.

m. Inspect clutch driving plates for cracked or glazed surfaces, or for cracked, worn, or broken teeth. Check for excessive wear. Replace damaged or worn driving plates.

n. Inspect pressure and center plates for warpage and discoloration. Replace damaged plates.

o. Inspect gears for scuffed, nicked, burred, or broken teeth. If defect cannot be removed with a soft stone, replace gear.

p. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

q. Inspect thrust faces of gears for scores, scratches, and burrs. If these defects cannot be removed with a soft stone, replace gear.

4-6. SPEED INCREASER REPAIR (CONT)

ASSEMBLY:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

NOTE

Replace all oil seals, gaskets, O-rings, lock plates, snap rings, etc., as a part of any maintenance or overhaul procedure. Shims which could be damaged or destroyed in disassembly should also be replaced.

Oiled torque values are given for all capscrews; therefore, capscrews should be oiled before installing.

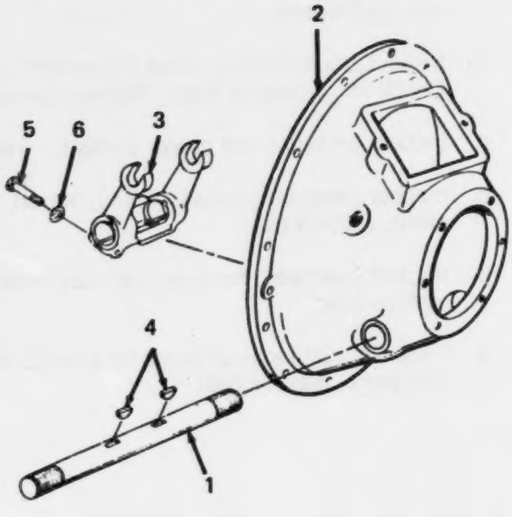
1 Assemble gear box assembly as follows:

a. Install operating shaft (1) half way into speed increaser housing (2). Slip throwout yoke (3) onto operating shaft, and push shaft through opening on other side of speed increaser housing.

b. Install one Woodruff key (4) into operating shaft.

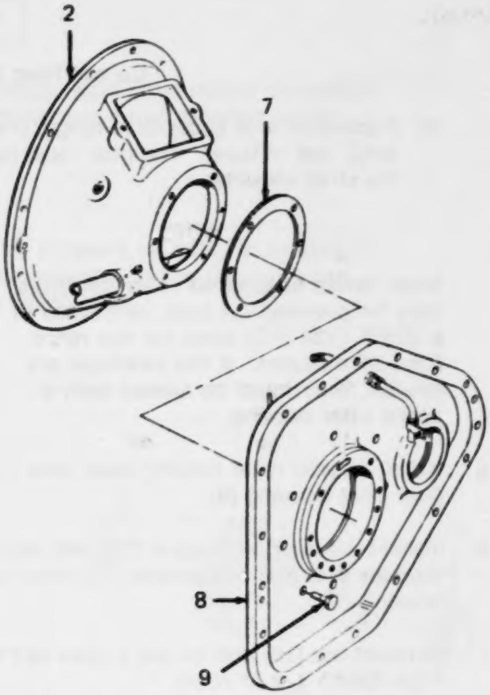
c. Move operating shaft enough to engage key (4) into yoke (3) and install a second Woodruff key (4).

d. Install operating shaft rest of the way into yoke and install screws (5) and lockwashers (6) into yoke (3). Torque screws 27 ± 2 ft-lbs (36.60 ± 2.71 N·m).



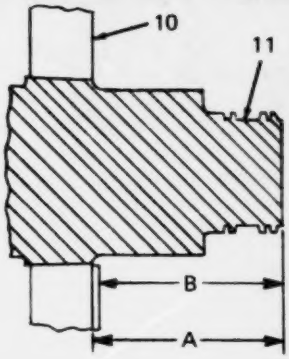
4-6. SPEED INCREASER REPAIR (CONT)

e. Position gasket (7) in place in speed increaser housing (2). Secure front gear housing (8) to speed increaser housing (2). Apply adhesive sealant to screw threads (9) and torque screws (9) to 65 ± 5 ft-lbs (88.12 ± 6.78 N•m).



f. Install input gear as follows:

(1) Clean mating surfaces of input gear (10) and shaft (11) with dry cleaning solvent.



CAUTION

Be careful not to touch these surfaces. Do not allow any oil or dirt to get on them.

(2) Install input gear (10) onto input shaft (11) and apply 200 lbs (889.64 N) force to seat it into its initial position.

(3) Measure and record dimensions A and B. Advance is A minus B. The advance must be between 0.083 inch (2.10 mm) and 0.125 inch (3.17 mm). If advance is not within this range, either a different shaft or different gear must be selected. Should removal of gear be necessary at this time, a sharp rap on front of gear with a rubber hammer should separate shaft and gear.

4-6. SPEED INCREASER REPAIR (CONT)

NOTE

Do not heat the gear nor cool the shaft.

(4) If advance is in acceptable range, press gear onto shaft so that it is flush with shoulder on shaft at small end of taper. The gear must be advanced to within +0.000/-0.002 inch (+0.000/-0.05 mm) of the shaft shoulder.

NOTE

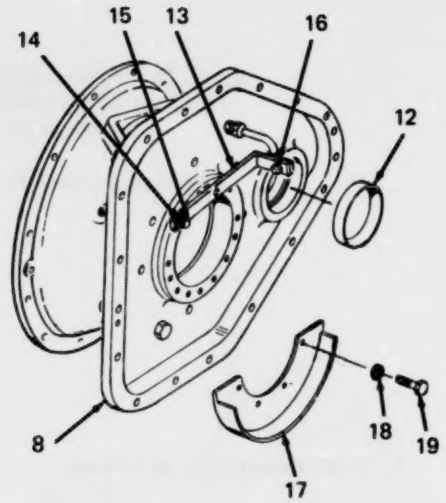
Inner races of tapered roller bearings may be pressed on cold, or heated in a 275°F (134.7°C) oven for not more than 30 minutes. If the bearings are heated, they must be seated with a press after cooling.

g. Install tapered roller bearing outer race (12) into gear front housing (8).

h. Install tube support bracket (13) with two lockwashers (14) and two screws (15) onto front housing (9).

i. Connect nut (16) and torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).

j. Install front baffle (17) and secure with four lockwashers (18) and four screws (19). Torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).



4-6. SPEED INCREASER REPAIR (CONT)

CAUTION

Special tools for seating tapered roller bearings must have inside diameters slightly larger than the shaft, and outside diameters small enough not to touch the cages and rollers.

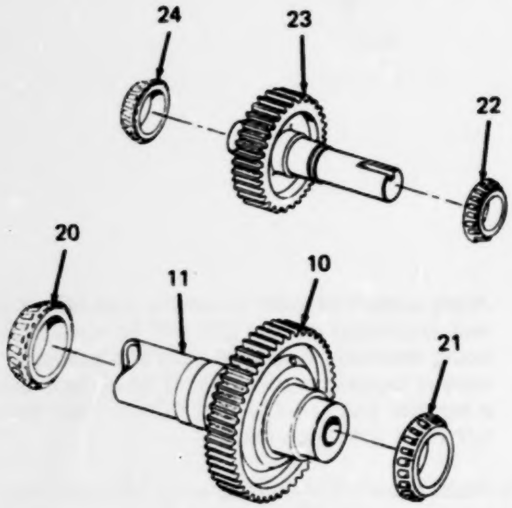
NOTE

Inner races of tapered roller bearings may be pressed on cold, or heated in a 275°F (134.7°C) oven for not more than 30 minutes. If the bearings are heated, they must be seated with a press after cooling.

k. Install inner race of bearing (20) over front of input shaft (11) and seat. Install inner race of bearing (21) over rear of input shaft (11) and seat.

l. Install inner race of bearing (22) onto rear of output shaft (23) and seat.

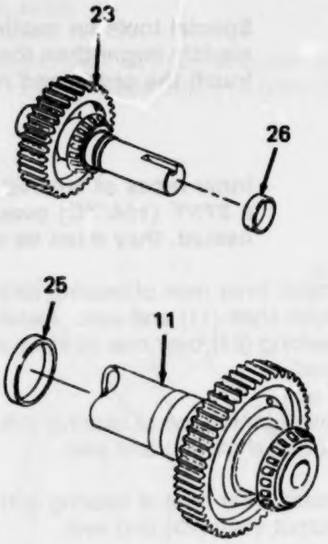
m. Install inner race of bearing (24) onto front of output shaft (23) and seat.

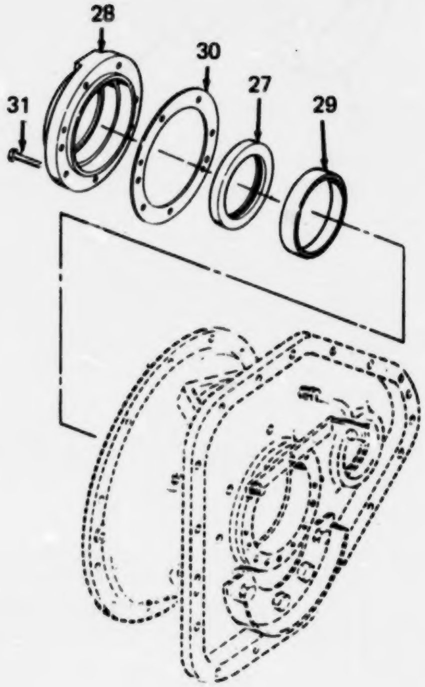


4-6. SPEED INCREASER REPAIR (CONT)

n. Apply sealant M-2828 to inside diameter of wear sleeve (25) and install new wear sleeve (25) onto shaft (11) using wear sleeve driver T-20134.

o. Apply sealant M-2828 to inside diameter of wear sleeve (26) and install new wear sleeve (26) onto the rear of gear shaft (23) using wear sleeve driver T-20135.





p. Apply sealant M-2828 to outside diameter of oil seal and install oil seal (27) with lip toward oil being retained. Seat seal against shoulder in bore of bearing carrier (28). Seat oil seal using a flat disc that is 4-5/8 (117.47 mm) diameter x 1/2 (12.7 mm) inch thick.

q. Install taper roller bearing outer race (29) into bearing carrier (28) and seat it against shoulder in bore of bearing carrier (28).

r. Install gasket (30) and bearing carrier (28). Secure with screws (31). Torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).

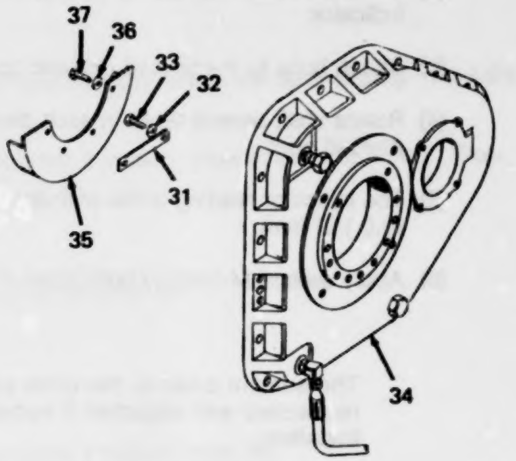
s. Install shaft (11) using extreme care not to cut oil seal.

t. Install shaft gear (23).

4-6. SPEED INCREASER REPAIR (CONT)

u. Install oil dam (31) with two lockwashers (32) and two screws (33) onto rear housing (34). Torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).

v. Install rear baffle (35) with four lockwashers (36) and four screws (37). Torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).



w. Install gasket (38) and rear housing (34). Secure with screws (39). Torque to 65 ± 5 ft-lbs (88.13 ± 6.78 N•m).

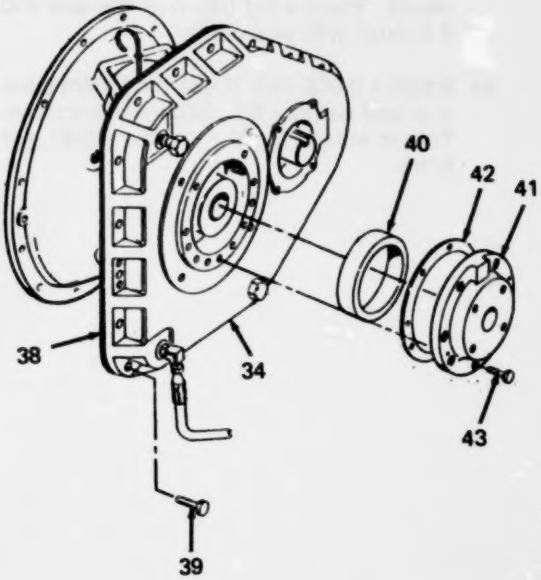
x. Install tapered roller bearing outer race (40) into the bore of bearing carrier (41) and seat against the shoulder.

y. Install a 0.080 shim pack (42) and bearing carrier (41). Secure with capscrews (43). Torque the capscrews to 27 ± 2 ft-lbs (36.60 ± 2.71 N•m).

z. Turn unit over with input shaft up. Apply downward pressure into input shaft while rotating input shaft several times in each direction.

aa. Check shaft end play as follows:

(1) Thread special lifting bail T-20209 onto shaft.



4-6. SPEED INCREASER REPAIR (CONT)

(2) Install indicator with the tip resting on end of shaft. Mark the spot where the tip is resting. Zero the indicator.

(3) Attach hoist to the special tool and apply upward pressure onto shaft.

(4) Rotate shaft several times in each direction with upward pressure applied. Stop with the tip on the marked spot.

(5) The indicator reading is the endplay. Remove shims to adjust endplay to 0.004 to 0.006 inch (0.10 to 0.152 mm).

(6) Apply sealant M-2828 to both sides of each shim.

NOTE

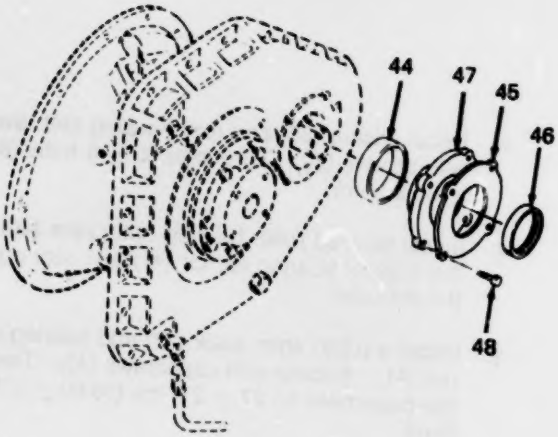
The sealant adds to the shim pack. Therefore, the endplay must be rechecked and adjusted if necessary after the shims with sealant are installed.

ab. Turn the unit over so that output side is up.

ac. Install roller bearing outer race (44) just far enough into housing so that seal carrier (45) can be started.

ad. Apply sealant M-2828 to the outside diameter of oil seal (46) and install oil seal into the bore of seal carrier (45) with lip toward oil being retained. Place a flat disc over the seal and drive it in flush with seal carrier.

ae. Install a 0.065 inch (1.651 mm) shim pack (47) and seal carrier (45). Secure with screws (48). Torque screws to 27 ± 2 ft-lbs (36.60 ± 2.71 N·m).



4-6. SPEED INCREASER REPAIR (CONT)

af. Press downward on output gear shaft while rotating it several times in each direction.

ag. Install eyebolt into end of shaft.

ah. Mount indicator with the tip resting on end of shaft, and mark the spot where the tip is resting. Zero the indicator.

ai. Attach hoist and apply upward pressure on shaft while rotating it several times in each direction. Stop with the tip resting on the marked spot.

aj. The indicator reading is the endplay.

ak. Remove shims to adjust endplay to 0.004 to 0.006 inch (0.10 to 0.152 mm).

al. Apply sealant M-2828 to both sides of each shim.

NOTE

The sealant adds to the shim pack. Therefore, the endplay must be rechecked after the shims with sealant are installed.

2 Assemble the speed increaser as follows:

a. Set clutch hub and back plate assembly on bench with hub section facing up.

4-6. SPEED INCREASER REPAIR (CONT)

b. Install driving plate (49) onto hub and backplate (50).

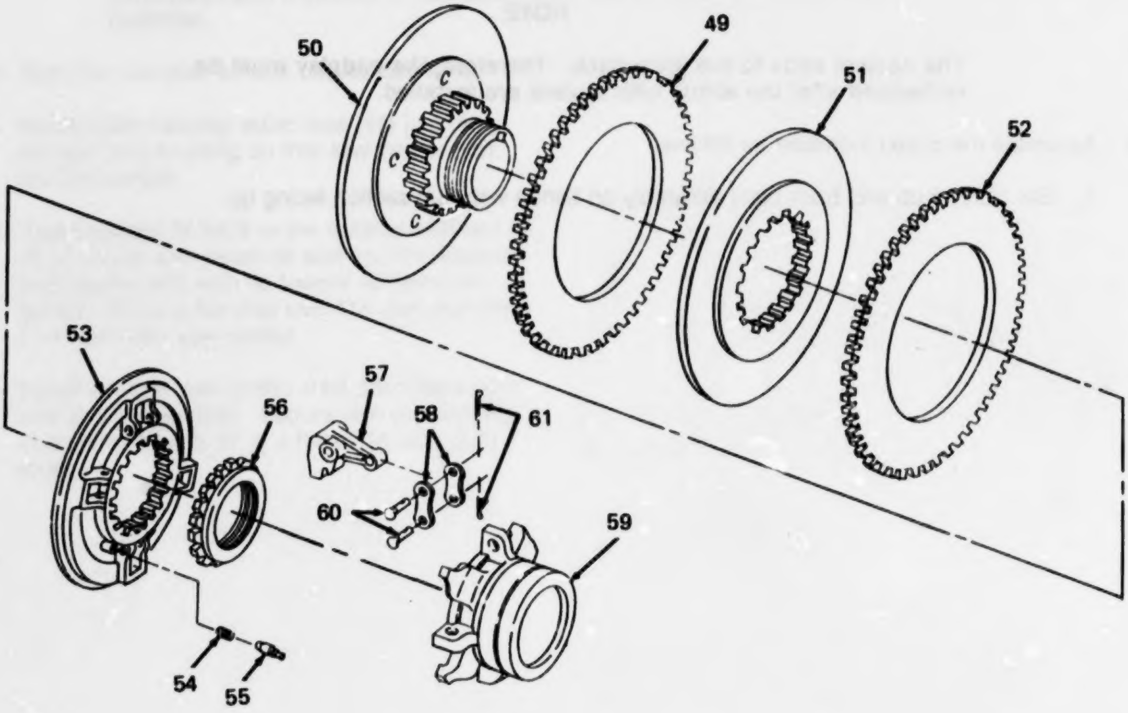
c. Install center plate (51) onto first driving plate (49).

d. Install second driving plate (52) and floating plate (53).

e. Install adjusting lock pin spring (54) and adjusting lock pin (55) into bore provided in floating plate (53).

f. Depress pin and spring with a screwdriver while installing adjusting ring (56). Screw ring halfway down hub thread.

g. Install four levers (57) and eight lever links (58) to lugs on sliding sleeve (59) with eight lever link pins (60) and eight cotter pins (61). Spread cotter pins so their ends do not exceed a 0.47-inch (11.94 mm) radius for operating clearance.



4-6. SPEED INCREASER REPAIR (CONT)

h. Install ball bearing (62) onto sliding sleeve (59). Install external snap ring (63).

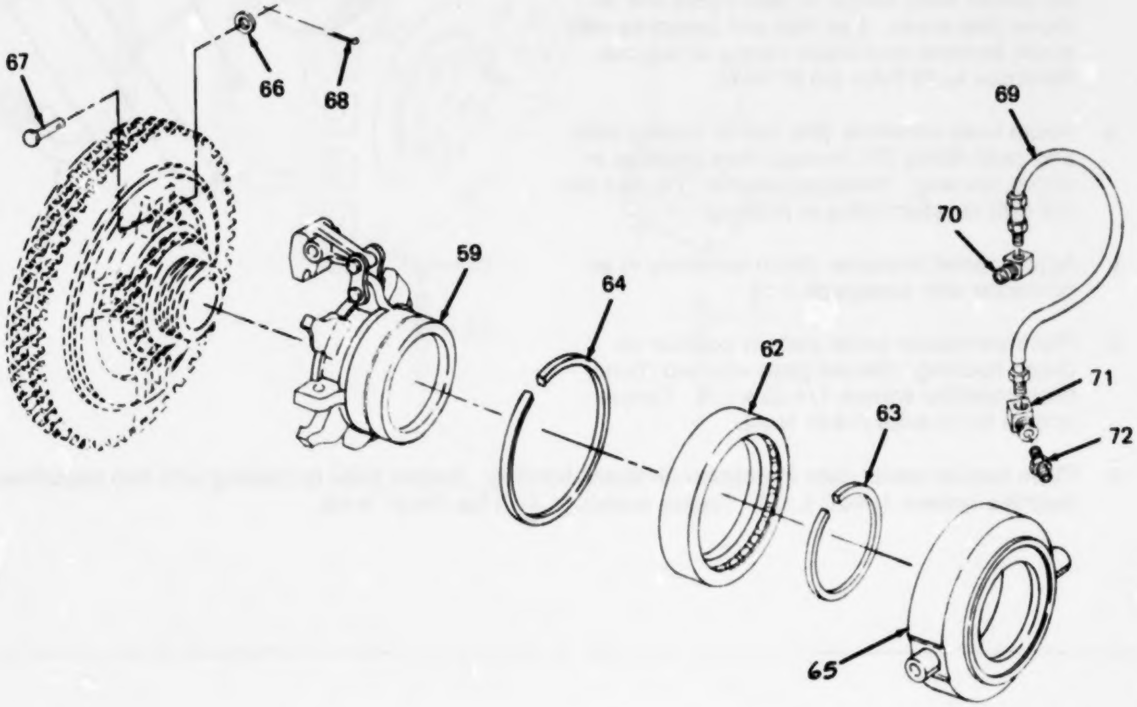
i. Install internal snap ring (64) onto sliding sleeve (59) moving snap ring over ball bearing.

j. Install sleeve collar (65) over ball bearing and install internal snap ring (64) into groove in sleeve collar bore (65).

k. Install levers, sliding sleeve, and collar group as an assembly onto adjusting ring and floating plate.

l. Retain levers to floating plate with eight spring washers (66), one on each lever, four lever link pins (67), and four cotter pins (68).

m. Install hose assembly (69). Install hose fitting (70) into sleeve collar (65). Install hose (69) into fitting (70). Install hose fitting (71) onto hose (69). Install hydraulic (grease) fitting (72) into hose fitting (71).



4-6. SPEED INCREASER REPAIR (CONT)

n. Set clutch housing (2) with attached parts on a bench with clutch end facing up and support firmly on wooden blocks.

o. Lower clutch assembly (73) over clutch shaft and onto clutch housing, engaging trunnions on sleeve collar with throwout yoke.

p. Align shaft keyway with keyway in hub and backplate. Install key (74).

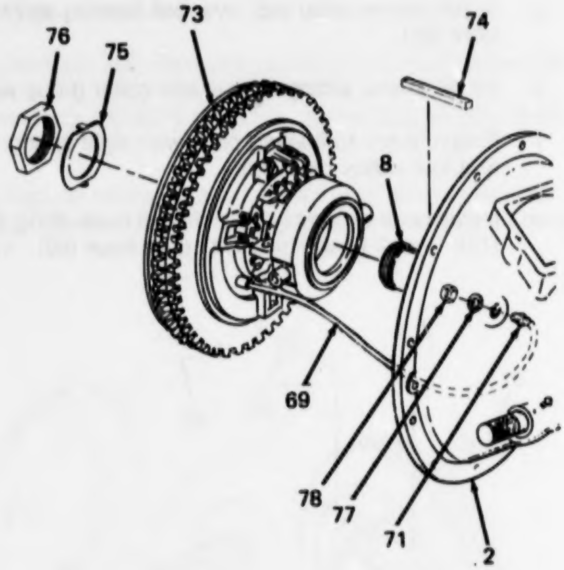
q. Install hub nut lockwasher (75) onto clutch shaft, indexing its lower tab in spot drilling provided on hub and backplate.

r. Install hub nut (76). Tighten hub nut using 30 ft-lbs (40.67 N•m) torque to seat tapers and remove clearances. Rap hub and backplate with a soft hammer and check torque of hub nut. Retorque to 30 ft-lbs (40.67 N•m).

s. Route hose assembly (69) free of moving parts and push fitting (71) through hole provided in clutch housing. Install lockwasher (77) and jam nut (78) to retain fitting in housing.

t. Adjust speed increaser clutch assembly in accordance with paragraph 3-18.

u. Place instruction cover plate in position on clutch housing. Secure plate with two roundhead machine screws 1/4-20 x 1/2. Torque screws to 11 ft-lbs (14.91 N•m).



v. Place bottom cover plate in position on clutch housing. Secure plate to housing with two roundhead machine screws 1/4-20 x 1/2. Torque screws to 11 ft-lbs (14.91 N•m).

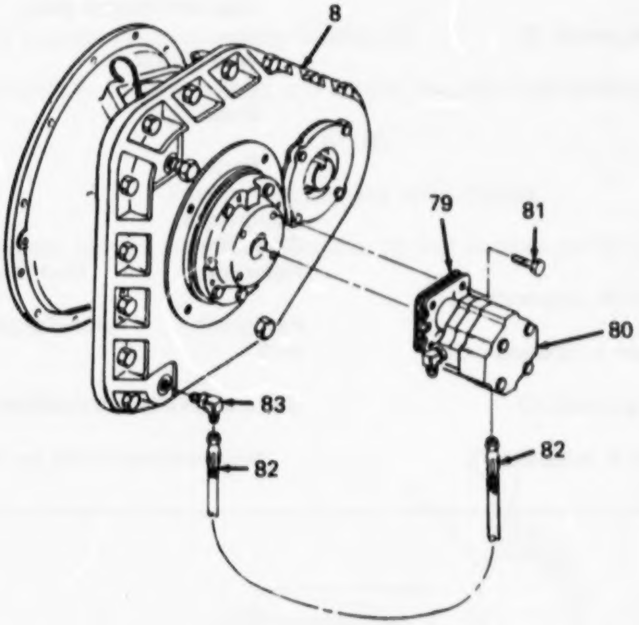
4-6. SPEED INCREASER REPAIR (CONT)

w. Install gasket (79) and pump (80). Secure with screws (81). Torque screws to 15 ± 2 ft-lbs (20.33 ± 2.71 N·m).

x. Install hose (82) between pump (80) and sump (83).

3 Connect heat exchanger in accordance with paragraph 2-34.

4 Check flywheel and flywheel housing alignment in accordance with paragraph 3-37.



4-7. TURBOCHARGER (HC3-16) REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

- Tool kit, general mechanics (Item 1, Appendix B)
- Snap ring pliers (Item 2, Appendix B)
- Torque wrench (Item 2, Appendix B)
- Dial indicator (Item 3, Appendix B)
- T-handle wrench
- Arbor press

Materials/Parts

- Dry cleaning solvent (Item 30, Appendix C)
- Crocus abrasive cloth (Item 1, Appendix C)
- Lubricating oil (Item 22, Appendix C)
- Antiseize compound (Item 6, Appendix C)

Materials/Parts

- Locknuts
- O-ring
- Vice with copper jaws
- Wire basket
- Brass pipe
- Rags

Equipment Condition Reference	Condition Description
Paragraph 2-40	Turbocharger removed

General Safety Instructions

Well ventilated area for cleaning

DISASSEMBLY:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

CAUTION

The turbocharger contains parts which have precision machined surfaces. Use extreme care during disassembly to prevent damage to machined surfaces.

1 Prior to disassembling turbocharger, clean exterior surfaces with dry cleaning solvent and dry with a clean rag.

4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

2 Before disassembly of turbocharger, match mark compressor housing (1), bearing housing (2), and turbine housing (3) to help in realignment during assembly.

3 Remove nut (4) on V-clamp (5).

4 Lift off V-clamp (5).

5 Remove turbine housing (3) from bearing housing (2).

6 Remove 10 capscrews (6), lockwashers (7), and clamp plates (8) that secure compressor housing (1) to bearing housing (2).

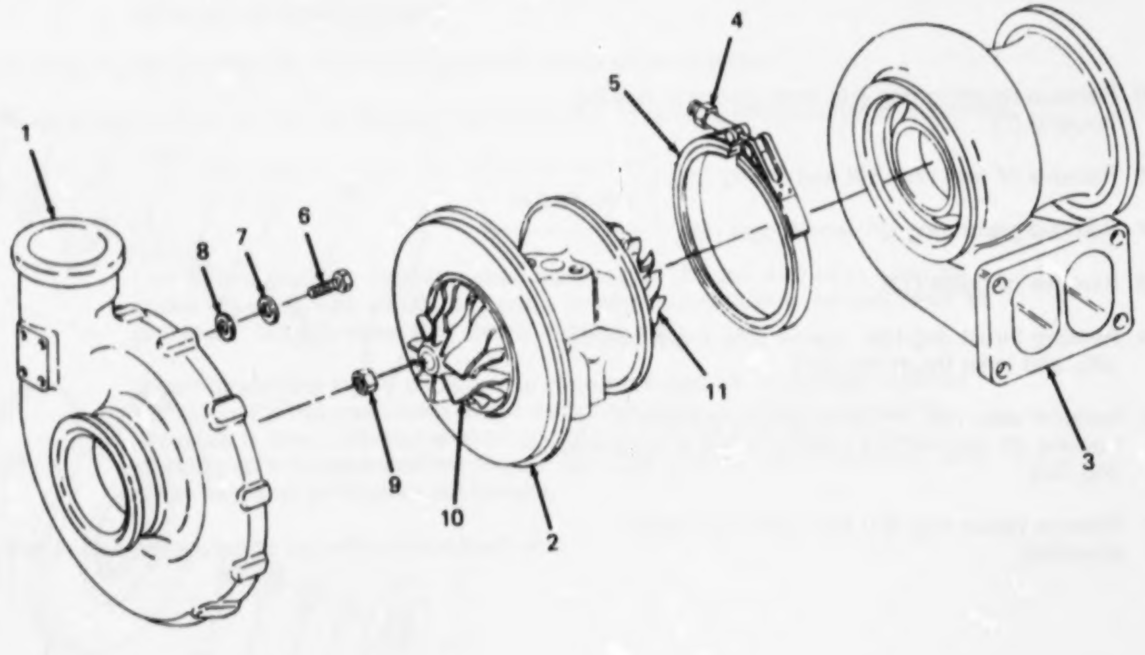
7 Remove compressor housing (1) from bearing housing (2).

8 Place turbine end of shaft in a vise equipped with copper jaws and tighten vise firmly but do not overtighten.

NOTE

Locknut (9) has left hand thread.

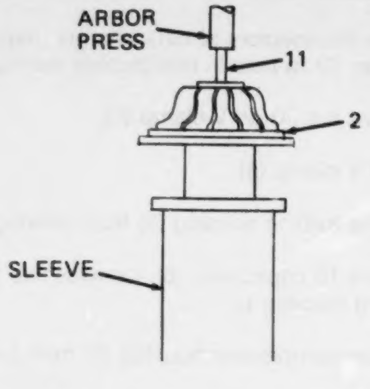
9 Using a T-handle wrench, remove and discard locknut (9) that secures compressor wheel (10) to shaft and wheel assembly (11).



4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

10 Place bearing housing (2) in special sleeve or short length of suitable diameter brass pipe so that turbine end flange is supported in sleeve. Place clean rags at bottom of sleeve to prevent damage to turbine wheel.

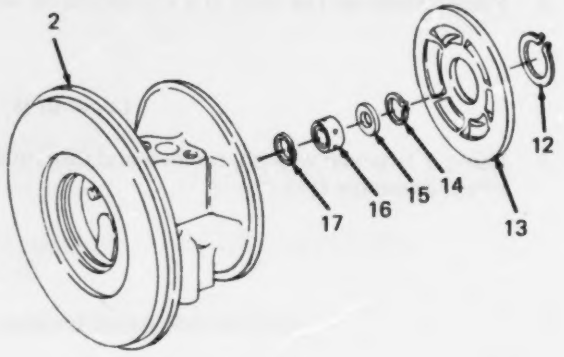
11 Position bearing housing (2) and sleeve in arbor press so that press bears on compressor shaft end of shaft and wheel assembly (11) and press wheel assembly (11) from bearing housing (2).



12 Remove retaining ring (12) from groove in bearing housing (2).

13 Remove heat shield (13) from bearing housing (2).

14 Remove outer snap ring (14), oil control ring (15), bearing (16), and inner snap ring (17) from bearing housing (2).



15 Remove retaining ring (18) from groove in bearing housing (2).

16 Remove oil seal ring (19) and O-ring (20).

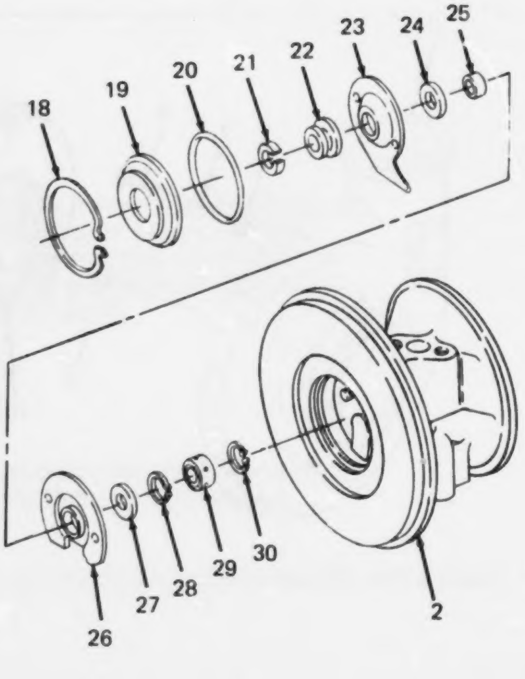
17 Remove piston ring (21) and slinger (22).

18 Remove oil baffle (23).

19 Remove thrust ring (24), spacer (25), thrust bearing (26), and inner thrust ring (27).

20 Remove snap ring (28) from groove in bearing housing (2) and remove bearing (29) and inner snap ring (30).

21 Remove piston ring (31) from shaft and wheel assembly.



4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

NOTE

Hard carbon deposits will form on the turbocharger parts which are very difficult to remove with ordinary solvents. The cleaner must be capable of removing hard deposits without damaging the metal.

1 Place all parts in a divided wire basket so that parts are not in contact, to avoid damage to precision machined surfaces.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

2 Soak parts in dry cleaning solvent for 12 to 24 hours.

CAUTION

Do not use wire brush to clean turbocharger parts. Use of wire brush may damage machined surfaces.

3 Remove carbon loosened by dry cleaning solvent with soft bristle brush.

4 Flush all oil passages in bearing housing from drain end, to remove dirt loosened by cleaning.

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, shall be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

5 Steam clean all parts and dry with compressed air.

4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

6 Place parts carefully in a clean basket to avoid damage or dirt.

7 Inspect compressor wheel for the following:

  a. Signs of rubbing

  b. Damage from foreign material

  c. Signs of burning in bore area

  d. Signs of seals rubbing running surfaces.

8 Inspect compressor housing for the following:

  a. Scoring due to contact with compressor wheel. If small scratches or chips are found they can be smoothed out with crocus cloth.

  b. Cracks or distortion. Discard housing if cracked or distorted.

9 Inspect turbine shaft and wheel assembly for the following:

  a. Signs of rubbing

  b. Vane edges worn to fine edge

  c. Scoring or scratches on shaft

  d. Seized bearings

  e. Cracks in turbine wheel. Check with dry penetrant.

  f. Scoring of turbine thrust shoulder.

10 Measure shaft bearing journal diameters. Replace wheel and shaft assembly if journal diameters are worn below 0.5612 inch (14.25 mm).

11 Inspect turbine housing for the following:

  a. Scoring due to contact with rotating parts

  b. Cracks or distortion. Discard housing if cracked or distorted.

  c. Cracking, distortion, or signs of burning at mounting flange.

12 Inspect bearing housing for cracks, pitting, and distortion. Pay particular attention to inlet and outlet parts of oil passages. Discard bearing housing if damaged.

13 Measure bearing housing bearing bores. Replace bearing housing if bore diameter exceeds 0.8762 inch (22.255 mm).

4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

ASSEMBLY:

CAUTION

All parts and work area must be free of grease, oil, and dirt to keep abrasives out of the turbocharger during assembly.

1 Coat all bearings, thrust bearing, thrust rings, and piston ring with a light coat of lubricating oil.

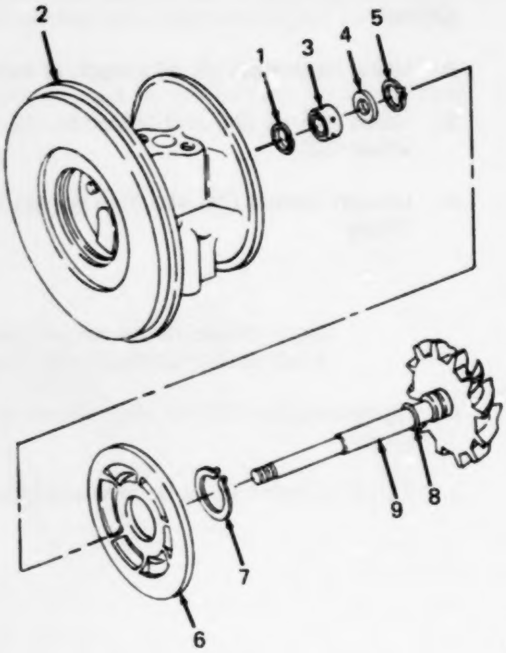
2 Install new snap ring (1) in turbine end of bearing housing (2).

3 Install new bearing (3), new oil control sleeve (4), and outer snap ring (5).

4 Install heat shield (6) and retaining ring (7).

5 Install new piston ring (8) against shoulder of shaft and wheel assembly (9).

6 Insert shaft and wheel assembly (9) through bearing housing (2).



4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

7 Install new snap ring (10) into groove in bearing housing (2) at compressor end.

8 Install new bearing (11) and new outer snap ring (12) over shaft and into bore of bearing housing (2).

9 Install new thrust ring (13), new thrust bearing (14), new spacer (15), and new thrust ring (16) over shaft and into bore of bearing housing (2).

10 Install oil baffle (17), slinger (18), and new piston ring (19) over shaft and into bore of bearing housing (2).

11 Install new O-ring (20) and oil seal plate (21) and secure into bearing housing (2) with retaining ring (22).

12 Install compressor wheel (23), at room temperature, on shaft of shaft and wheel assembly (9), and secure as follows:

a. Using lubrication oil, oil threads of locknut (24) and area of impeller face that will be under the nut.

b. Install locknut (24) and tighten to 125-150 in-lbs (14.13 to 16.95 N•m) torque. This will seat compressor wheel (23).

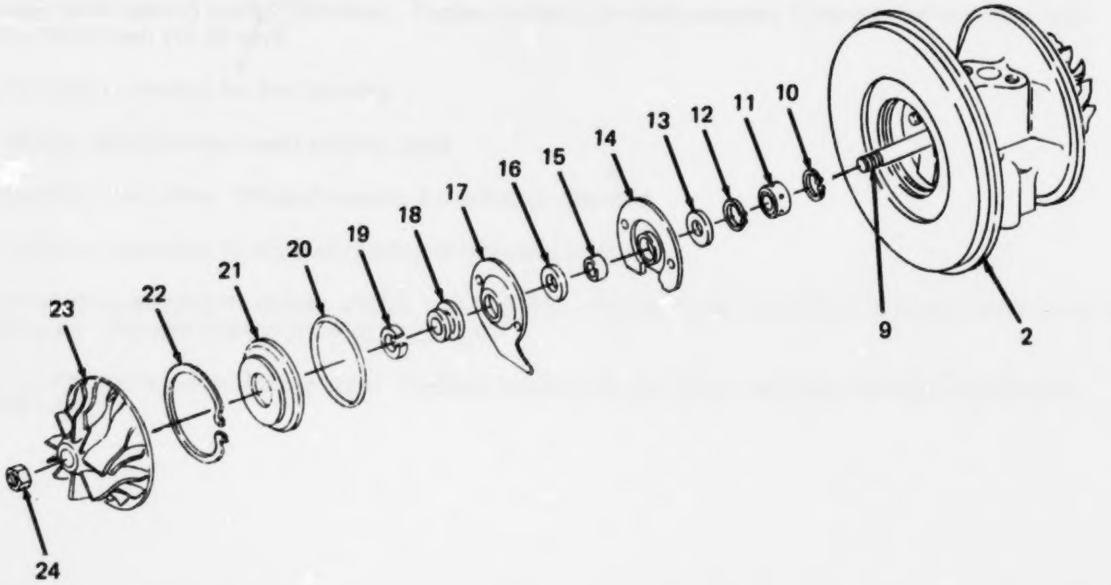
c. Loosen locknut (24) and then tighten to 35 to 55 in-lbs (3.96 to 6.22 N•m) torque greater than drag torque.

NOTE

Drag torque is the torque required to move the nut on threaded portions of shaft before contact with impeller.

d. Tighten locknut (24) for shaft stretch of 0.009 to 0.010 inch (0.23 to 0.24 mm) using a T-handle or flexible socket.

e. If shaft stretch cannot be measured, turn locknut (24) an additional 110 degrees after stop.



4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

13 Position compressor housing (25) on bearing housing (2) and line up match marks made before disassembly.

14 Coat threads of capscrews (26) with high temperature antiseize compound.

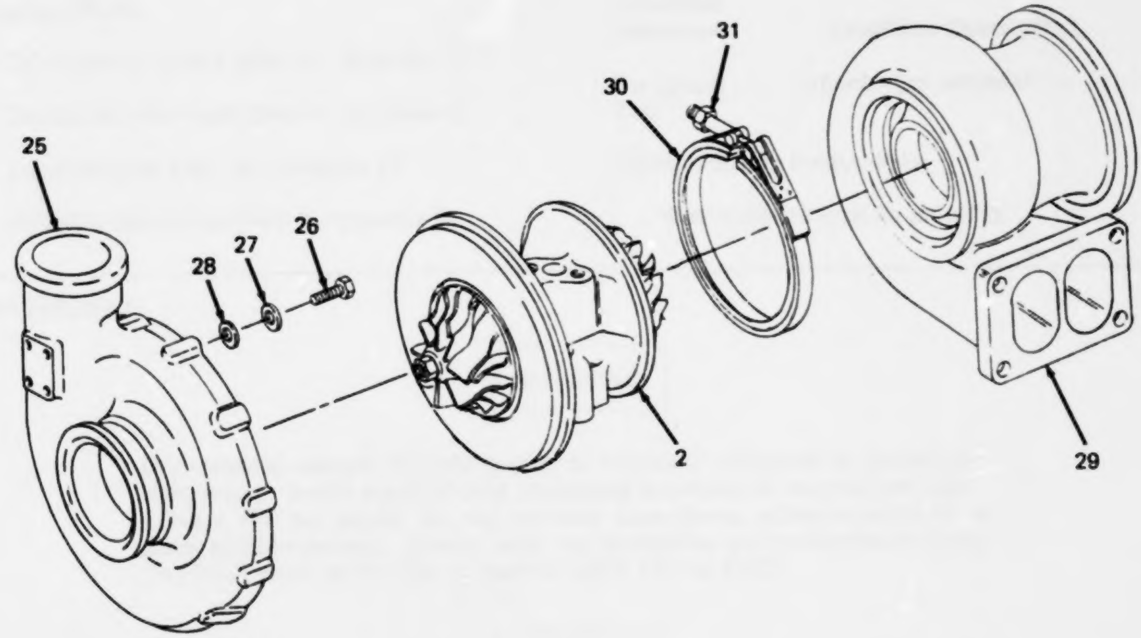
15 Install 10 capscrews (26) with lockwashers (27) and clamp plates (28).

16 Position turbine housing (29) on bearing housing and line up match marks.

17 Install V-clamp (30) and tighten new locknut (31) to 120 in-lbs (13.5 N•m) to secure turbine housing (29) to bearing housing (2).

18 After assembly, push rotating assembly as far as possible from turbine end, rotate and check for binding. Repeat check, pushing from compressor end.

19 Use dial indicator to check total end clearance. Total end clearance must be within 0.001 inch (0.03 mm) and 0.004 inch (0.10 mm).



4-7. TURBOCHARGER (HC3-16) REPAIR (CONT)

20 Check compressor radial clearance as follows:

a. Push shaft toward side of bore.

b. Using feeler gauge, check minimum distance between tip of impeller vanes and bore. The distance must be 0.008 to 0.016 inch (0.20 to 0.41 mm).

21 Check turbine radial clearance in accordance with step 23. The clearance must be 0.011 to 0.019 inch (0.28 to 0.48 mm).

22 Install turbocharger in accordance with paragraph 2-40.

4-8. TURBOCHARGER (T18-A) REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Snap ring pliers (Item 2, Appendix B)

Torque wrench (Item 2, Appendix B)

Dial indicator (Item 3, Appendix B)

T-handle wrench

Arbor press

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

Lubricating oil (Item 22, Appendix C)

Antiseize compound (Item 6, Appendix C)

Materials/Parts

Locknuts

O-ring

Vice with copper jaws

Wire basket

Brass pipe

Rags

Equipment Condition Reference	**Condition Description**
Paragraph 2-40	Turbocharger removed

General Safety Instructions

Well ventilated area for cleaning

DISASSEMBLY:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

CAUTION

The turbocharger contains parts which have precision machined surfaces. Use extreme care during disassembly to prevent damage to machined surfaces.

1 Prior to disassembling turbocharger, clean exterior surfaces with dry cleaning solvent and dry with a clean rag.

4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

2 Before disassembly of turbocharger, match mark compressor housing (1), turbine housing (2), and center housing (3) to help in alignment during assembly.

3 Remove V-band locknut (4) to loosen V-band clamp (5).

4 Remove V-band clamp (5) and discard locknut (4).

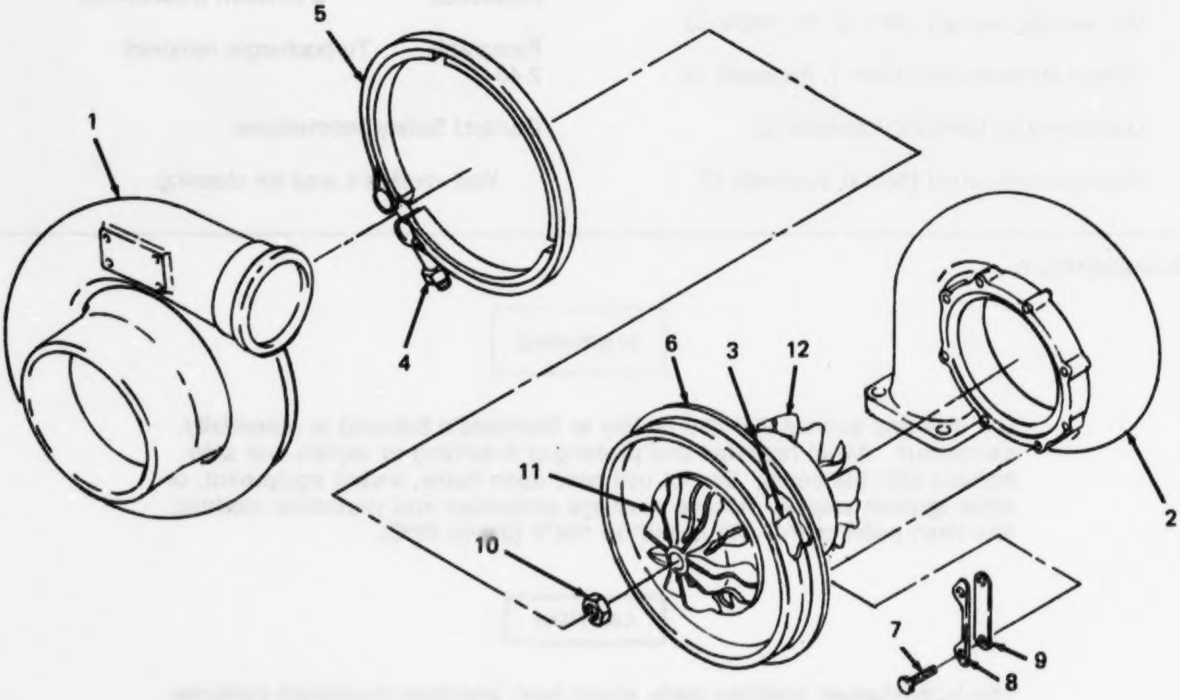
5 Remove compressor housing (1) from backplate (6).

6 Remove eight bolts (7), four lockplates (8), and four clamps (9) that secure turbine housing (2) to center housing (3) and discard lockplates (8).

7 Separate turbine housing (2) from center housing (3) and lift center housing assembly out of turbine housing.

8 Place turbine end of shaft in a vise equipped with copper jaws and tighten vise firmly but do not overtighten.

9 Using a T-handle wrench, remove locknut (10) that secures compressor impeller (11) to wheel and shaft assembly (12).



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

10 Place center housing assembly (3) in special sleeve or short length of suitable diameter brass pipe so that turbine end flange is supported by pipe.

11 Position center housing assembly (3) and pipe in arbor press so that press bears on compressor shaft end of wheel and shaft assembly (12).

12 Press wheel and shaft assembly (12) out of compressor impeller (11) and remove from center housing (3). Lift wheel shroud (13) off center housing.

13 Remove thrust spacer (14).

14 Remove four bolts (15) and washers (16) that secure backplate (6), and remove backplate from center housing (3).

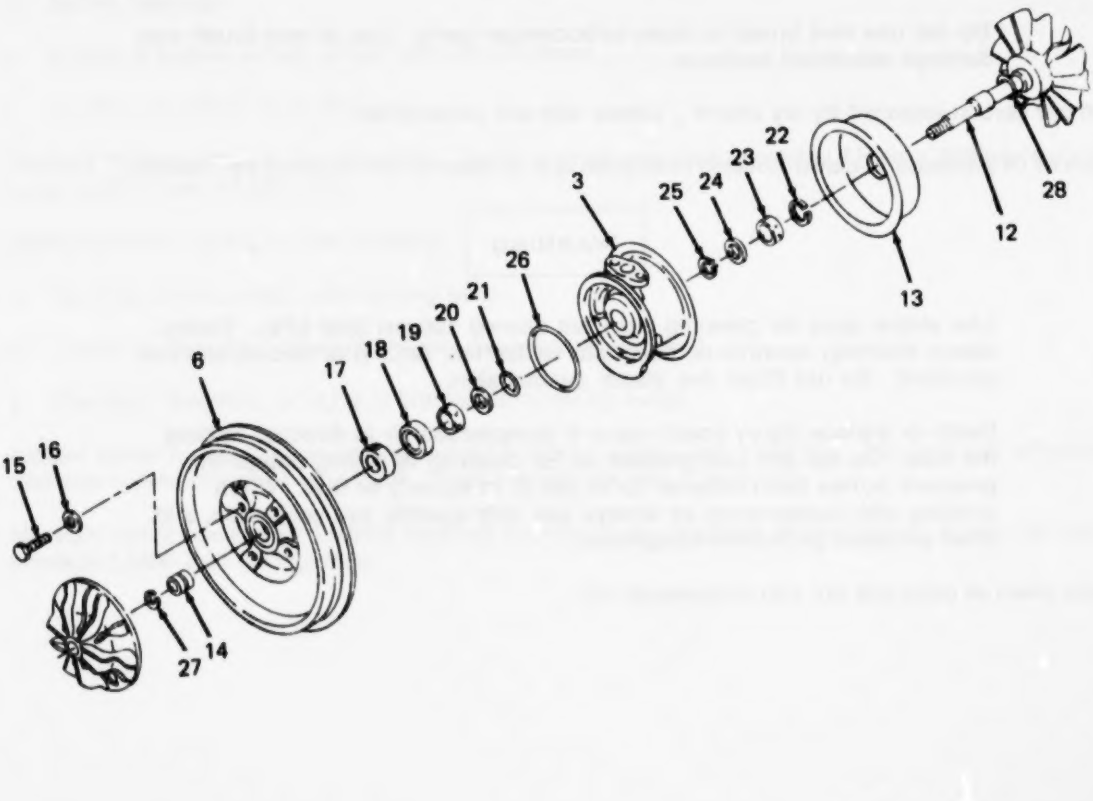
15 Remove thrust collar (17) and inboard thrust bearing (18) from center housing (3).

16 Remove bearing (19), washer (20), and retaining ring (21) from compressor end of center housing (3).

17 Remove outer retaining ring (22), bearing (23), washer (24), and inner retaining ring (25) from turbine end of center housing (3).

18 Remove O-ring (26) from center housing (3).

19 Remove piston ring (27) from thrust spacer (14) and piston ring (28) from shaft of wheel and shaft assembly (12).



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

NOTE

Hard carbon deposits will form on the turbocharger parts which are very difficult to remove with ordinary solvents. The cleaner must be capable of removing hard deposits without damaging metal.

1 Place all parts in a divided wire basket so that parts are not in contact, to avoid damage to precision machined surfaces.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

2 Soak parts in dry cleaning solvent for 12 to 24 hours.

CAUTION

Do not use wire brush to clean turbocharger parts. Use of wire brush may damage machined surfaces.

3 Remove carbon loosened by dry cleaning solvent with soft bristle brush.

4 Flush all oil passages in center housing from drain end, to remove dirt loosened by cleaning.

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, shall be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

5 Steam clean all parts and dry with compressed air.

4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

6 Place parts carefully in a clean basket to avoid damage or dirt.

7 Inspect compressor impeller for the following:

   a. Signs of rubbing

   b. Damage from foreign material

   c. Signs of burning in bore area

   d. Signs of seals rubbing the running surfaces.

8 Inspect compressor housing for the following:

   a. Scoring due to contact with compressor impeller. If small scratches or chips are found they can be smoothed out with crocus cloth.

   b. Cracks or distortion. Discard housing if cracked or distorted.

9 Inspect turbine wheel and shaft for following:

   a. Signs of rubbing

   b. Vane edges worn to fine edge

   c. Scoring or scratches on shaft

   d. Seized bearings

   e. Cracks in turbine wheel. Check with dry penetrant.

   f. Scoring of turbine thrust shoulder.

10 Measure shaft bearing journal diameters. Replace wheel and shaft assembly if journal diameters are worn below 0.6245 inch (15.862 mm).

11 Inspect turbine housing for the following:

   a. Scoring due to contact with rotating parts

   b. Cracks or distortion. Discard housing if cracked or distorted.

   c. Cracking, distortion, or signs of burning at mounting flange.

12 Inspect center housing (or bearing housing) for cracks, pitting, and distortion. Pay particular attention to inlet and outlet ports of oil passages. Discard center housing if damaged.

13 Measure center housing (or bearing housing) bearing bores. Replace center housing if bore diameter exceeds 0.9835 inch (24.981 mm).

4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

14 Inspect backplate for pitting, cracks, or distortion. Check vanes for chipping, wear, or corrosion. Replace backplate if damaged.

ASSEMBLY:

CAUTION

All parts and work area must be free of grease, oil, and dirt to keep abrasives out of the turbocharger during assembly.

1 Coat all bearings, bearing washers, thrust washers, thrust collar, and piston rings with a light coat of clean engine lubricating oil.

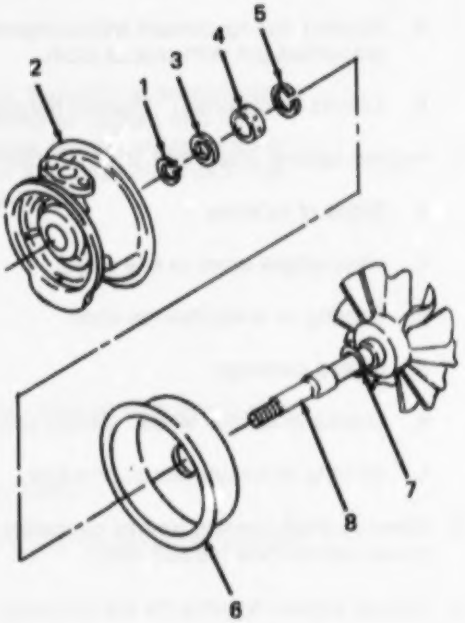
2 Install new retaining ring (1) in each end of center housing (2).

3 Install new bearing washer (3) and new bearing (4) against retaining ring (1) in turbine end of center housing (2) and secure using outer retaining ring (5).

4 Place wheel shroud (6) on center housing (2).

5 Place new piston ring (7) against shoulder of wheel and shaft assembly (8).

6 Insert wheel and shaft assembly (8) through center housing (2).



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

7 Install new bearing washer (9) over compressor end of shaft portion of wheel and shaft assembly (8), up to retaining ring (1).

8 Install new bearing (10) over shaft, up to bearing washer (9).

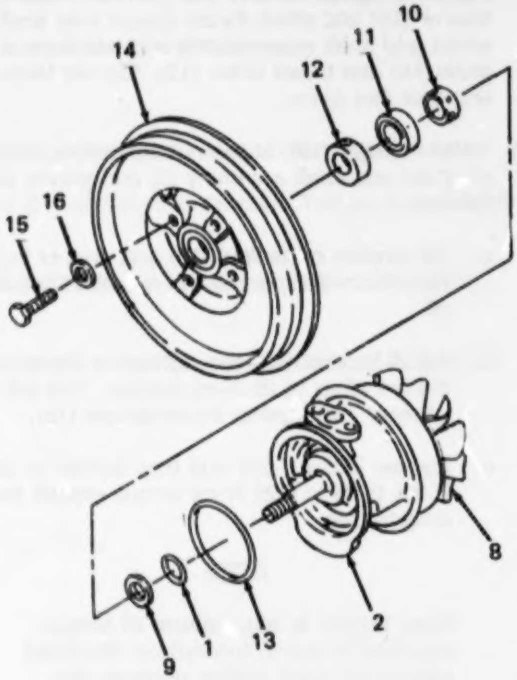
9 Install new inboard thrust bearing (11) with grooves facing out, on center housing (2). Make sure hole and cut-out engage pins in center housing and thrust bearing is seated flat against surface of housing.

10 Install new thrust collar (12).

11 Install new O-ring (13) in groove in center housing (2).

12 Align oil feed holes of center housing (2) and new backplate (14).

13 Install backplate (14) on center housing (2) using four bolts (15) and four washers (16). Torque bolts to 90 to 110 in-lbs (18.1 to 20.3 N•m) for cast iron back plates.



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

14 Install new piston ring (17) in groove of new thrust spacer (18) and place thrust spacer over shaft of wheel and shaft assembly (8) and into bore of backplate (14) and thrust collar (12). Do not force piston ring seal into place.

15 Install impeller (19), at room temperature, on shaft of wheel and shaft assembly (8) and secure as follows:

a. Oil threads of locknut (20) and area of impeller face that will be under the nut with lubricating oil.

b. Install locknut (20) and tighten to 125 to 150 in-lbs (14.13 to 16.95 N•m) torque. This will seat impeller (19) against thrust spacer (18).

c. Loosen locknut (20) and then tighten to 35 to 55 in-lbs (3.96 to 6.22 N•m) torque greater than drag torque.

NOTE

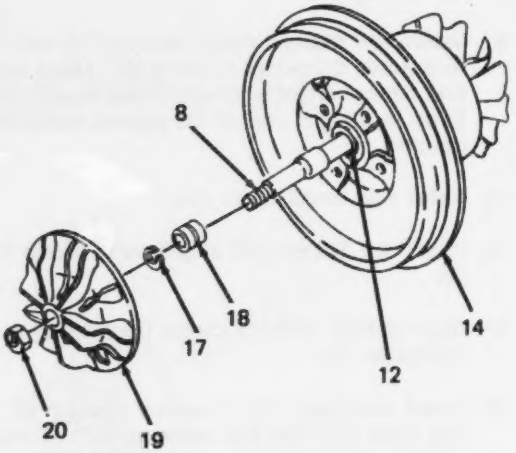
Drag torque is the amount of torque required to move the nut on threaded portion of shaft before contact with the impeller.

d. Tighten locknut (20) for shaft stretch of 0.009 to 0.010 inch (0.23 to 0.25 mm), using a T-handle or flexible socket.

e. If shaft stretch cannot be measured, turn locknut (20) an additional 110 degrees after step (c).

NOTE

This procedure is valid for T18-A turbochargers having 7/16 inch (11.11 mm) or 3/8 inch (9.52 mm) shaft.



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

16 Position compressor housing (21) on backplate (14) and line up match marks made before disassembly.

17 Install V-band coupling (22) and tighten locknut (23) to 40 to 60 in-lbs (4.5 to 6.8 N•m).

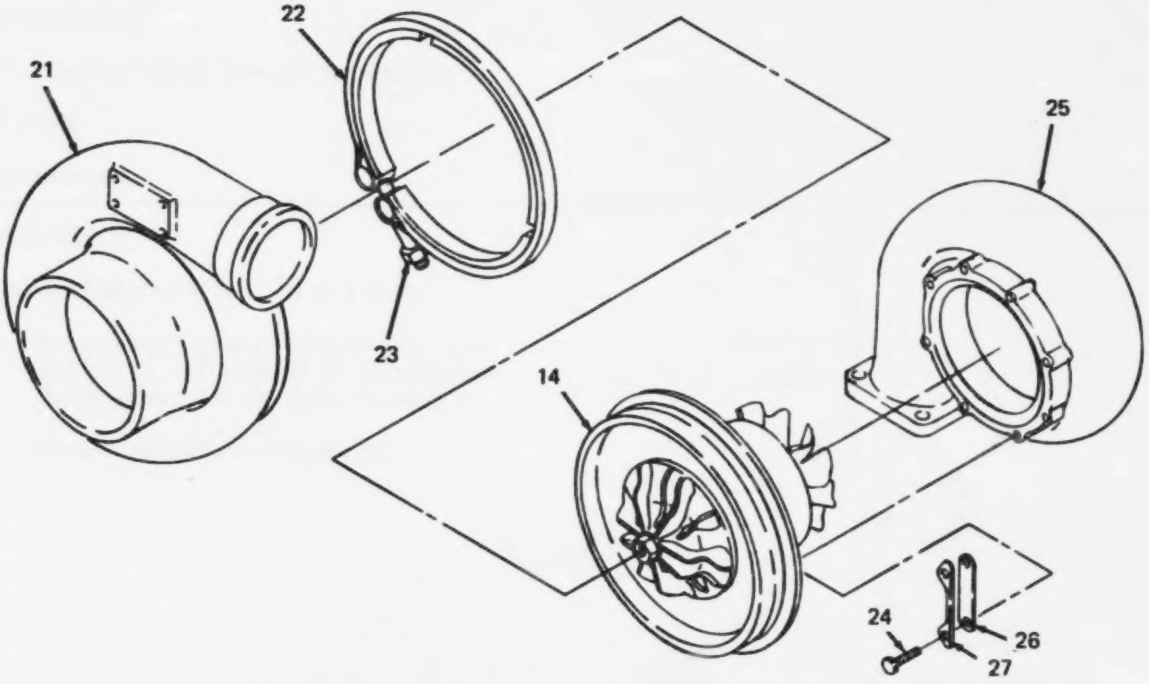
18 Coat threads of bolts (24) with antiseize compound.

19 Position turbine housing (25) on center housing (2) and line up match marks made before disassembly.

20 Install four turbine housing clamps (26), four new lockplates (27) and eight bolts (24). Torque bolts to 100 to 110 in-lbs (11.5 to 12.5 N•m).

21 After assembly, push rotating assembly as far as possible from turbine end, rotate and check for binding. Repeat check, pushing from compressor end.

22 Use dial indicator to check total end clearance. Total end clearance must be within 0.004 and 0.009 inch (0.10 to 0.23 mm).



4-8. TURBOCHARGER (T18-A) REPAIR (CONT)

23 Check compressor radial clearance as follows:

a. Push shaft toward side of bore.

b. Using feeler gauge, check minimum distance between tip of impeller vanes and bore. The clearance must be 0.006 to 0.028 inch (0.15 to 0.71 mm).

24 Check turbine radial clearance in accordance with step 23. The clearance must be 0.008 to 0.043 inch (0.20 to 1.09 mm).

25 Install turbocharger in accordance with paragraph 2-40.

4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly d. Calibration

INITIAL SETUP

Test Equipment

Fuel injection tester (test stand)

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Snap ring pliers (Item 2, Appendix B)

Retaining ring pliers (Item 2, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Gaskets

Lockwashers

Equipment Condition Reference	Condition Description
Paragraph 3-28	Fuel pump removed

General Safety Instructions

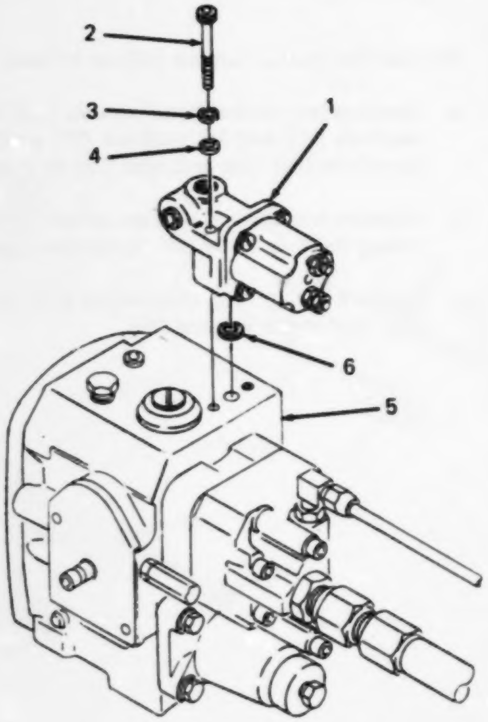
Well ventilated area for cleaning

DISASSEMBLY:

1 Remove fuel shutoff valve (1) as follows:

  a. Remove two socket head screws (2), lockwashers (3), and washers (4) securing fuel shutoff valve (1) to fuel pump housing (5).

  b. Remove rectangular ring seal (6).

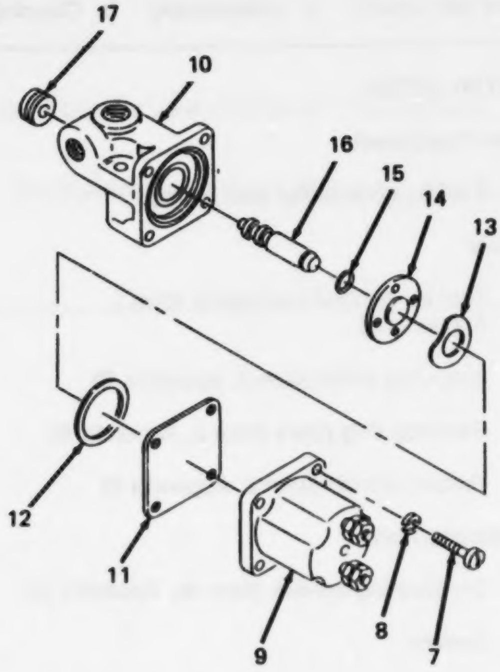


4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

c. Remove four capscrews (7) and lockwashers (8) securing solenoid (9) to shutoff valve body (10).

d. Remove shutoff valve housing shield (11), rectangular ring seal (12), valve spring (13), valve disc (14), O-ring seal (15), and shutoff valve shaft (16).

e. Insure knob (17) rotates freely in valve body (10).

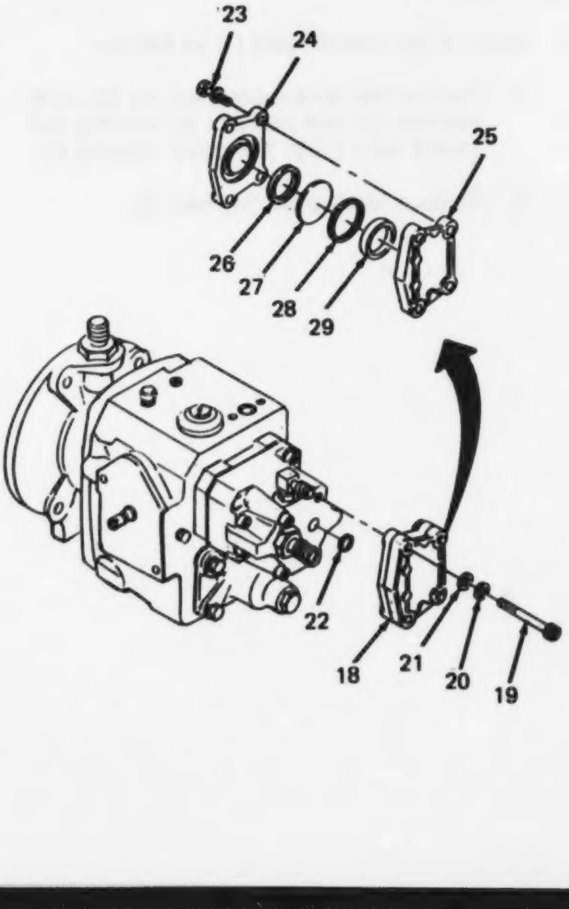


2 Remove fuel pump damper (18) as follows:

a. Remove two socket head screws (19), lockwashers (20) and flat washers (21) securing fuel pump damper (18) and seal (22) to gear pump.

b. Remove two captive washer screws (23) securing damper body (24) to damper plate (25).

c. Remove O-ring (26), diaphragm (27), O-ring (28), and nylon washer (29).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

3 Remove gear pump assembly (30) as follows:

a. Remove four socket head screws (31) and lockwashers (32) securing gear pump assembly (30) and gasket (33) to fuel pump housing (5).

b. Remove two socket head screws (34), lockwashers (35), and washers (36) securing cover and housing halves (37) together.

c. Remove gears (38), shaft (39), shaft (40), and gasket (41).

d. Remove plugs (42).

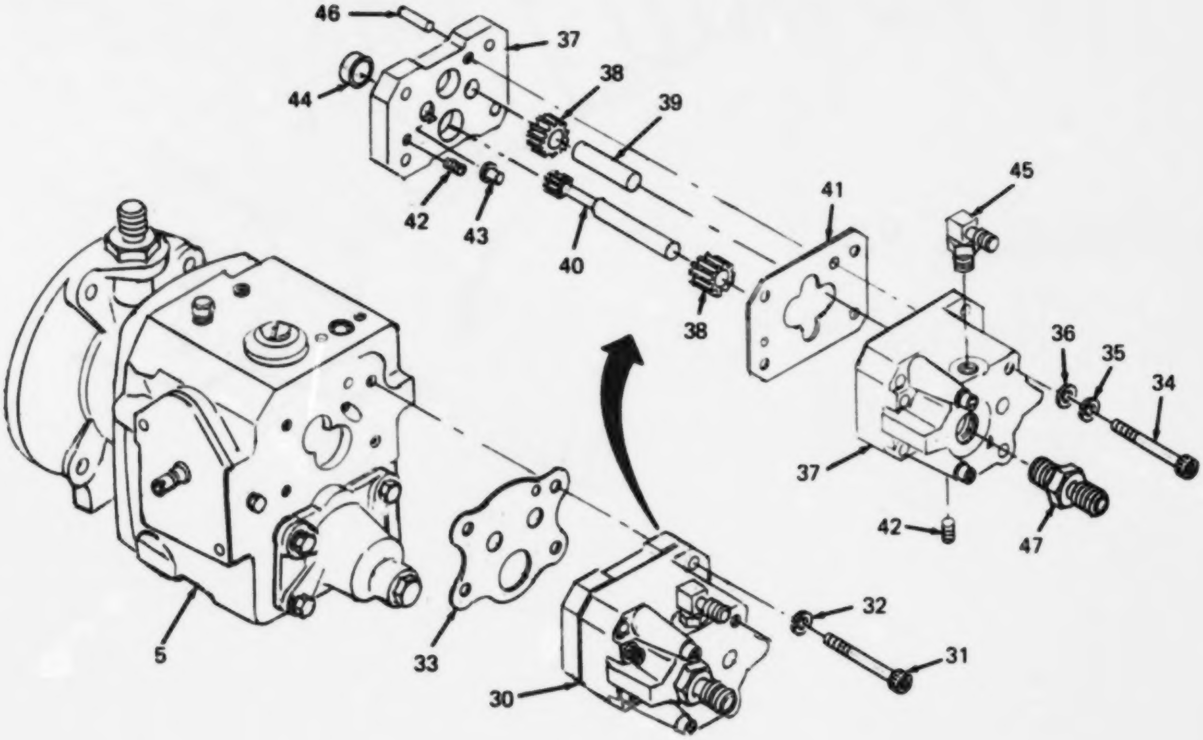
e. Remove pressure valve (43).

f. Remove dowel ring (44).

g. Remove check valve (45).

h. Remove dowel pin (46) if required.

i. Remove adapter (47).



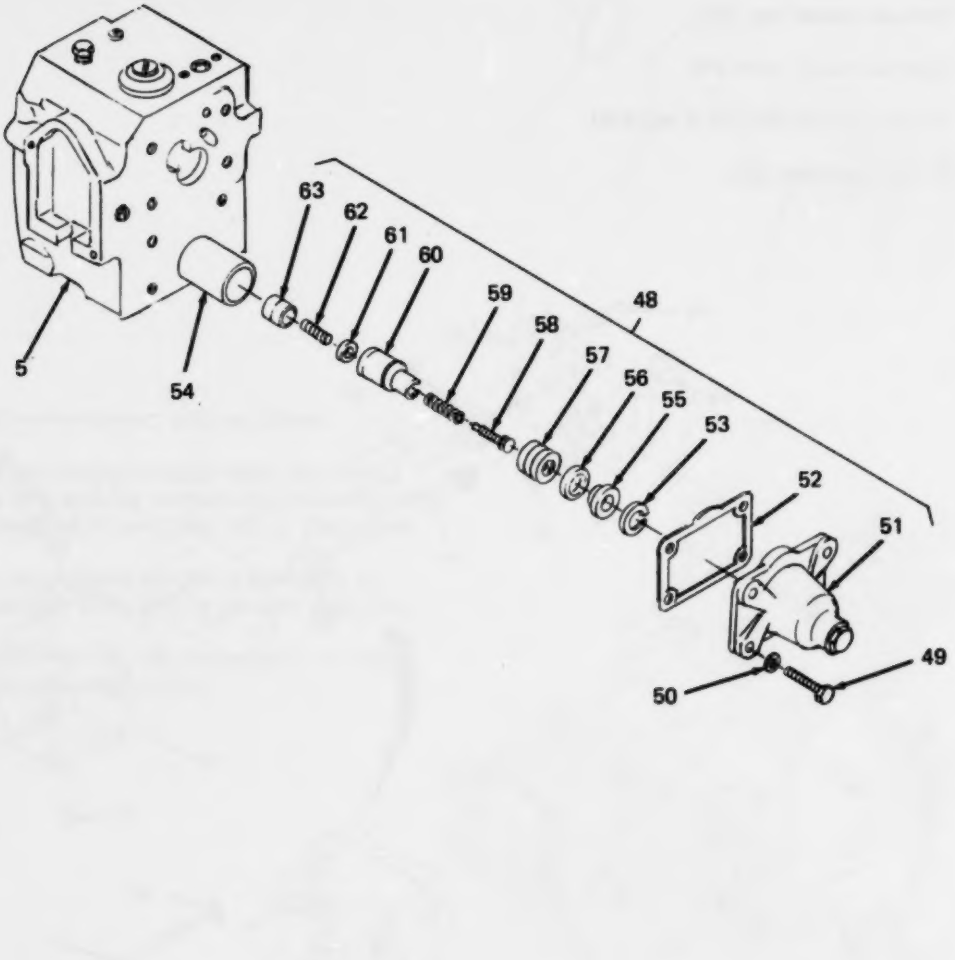
4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

4 Remove governor spring pack (48) as follows:

a. Remove four capscrews (49) and washers (50) securing spring pack cover (51) and gasket (52) to fuel pump housing (5).

b. Remove snap ring (53) from barrel (54).

c. Remove retainer (55), shim (56), governor spring (57), screw (58), spring (59), spring guide (60), washer (61), spring (62), and idle spring plunger (63).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

5 Remove main shaft cover and governor (64) as follows:

a. Remove six capscrews (65) and washers (66).

b. Remove socket head screw (67) and washer (68).

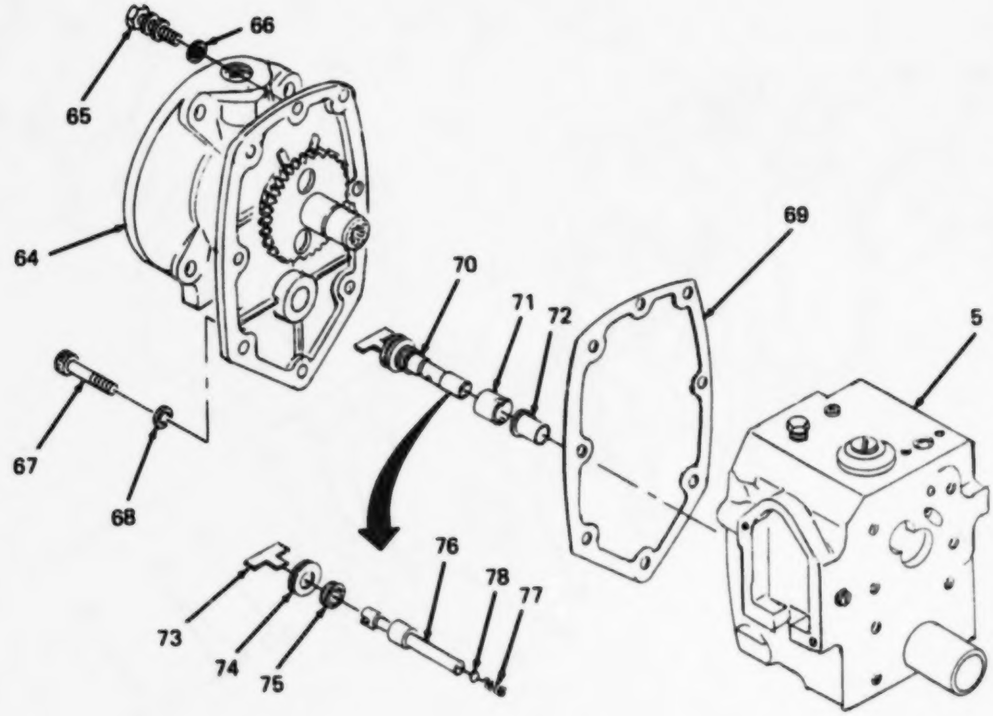
c. Remove main shaft cover and governor (64) and gasket (69) from pump housing (5).

d. Remove governor plunger assembly (70).

e. Remove governor barrel (71) and spring pack housing (72) from pump housing (5).

f. Remove governor plunger driver (73), washer (74), and governor spacer (75) from governor plunger (76).

g. Remove torque spring (77) and bypass valve shim (78) from governor plunger (76).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

h. Remove governor assembly (79) from pump housing (5).

i. Remove bushing (80) from main shaft cover and governor (64).

j. Remove weight assist plunger (81).

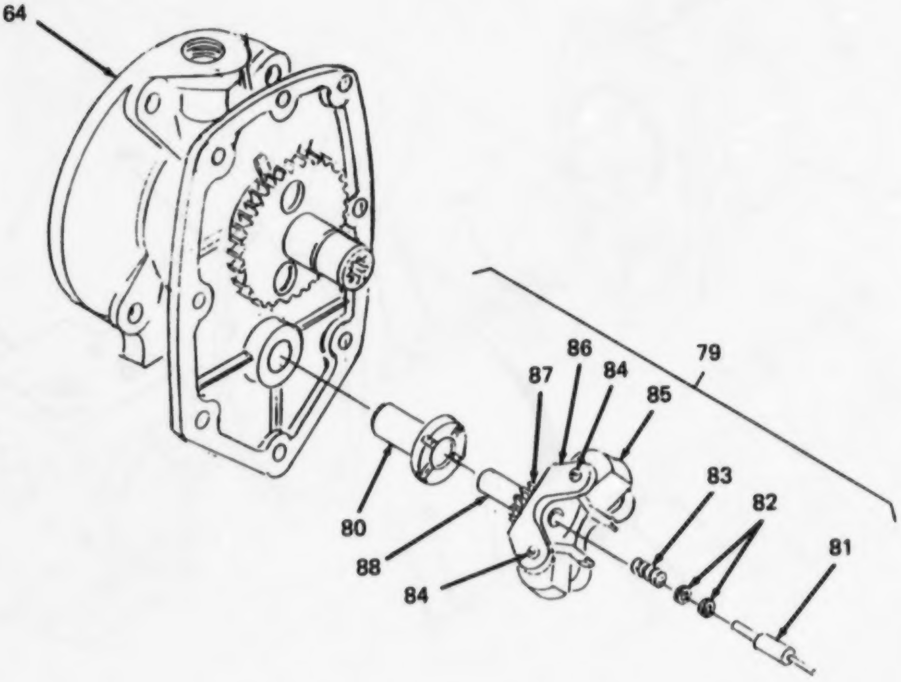
k. Remove weight assist shims (82).

l. Remove weight assist spring (83).

m. Remove weight pins (84) and remove governor weights (85) from weight carrier (86).

n. Remove gear (87) from shaft (88).

o. Remove weight carrier (86) from shaft (88).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

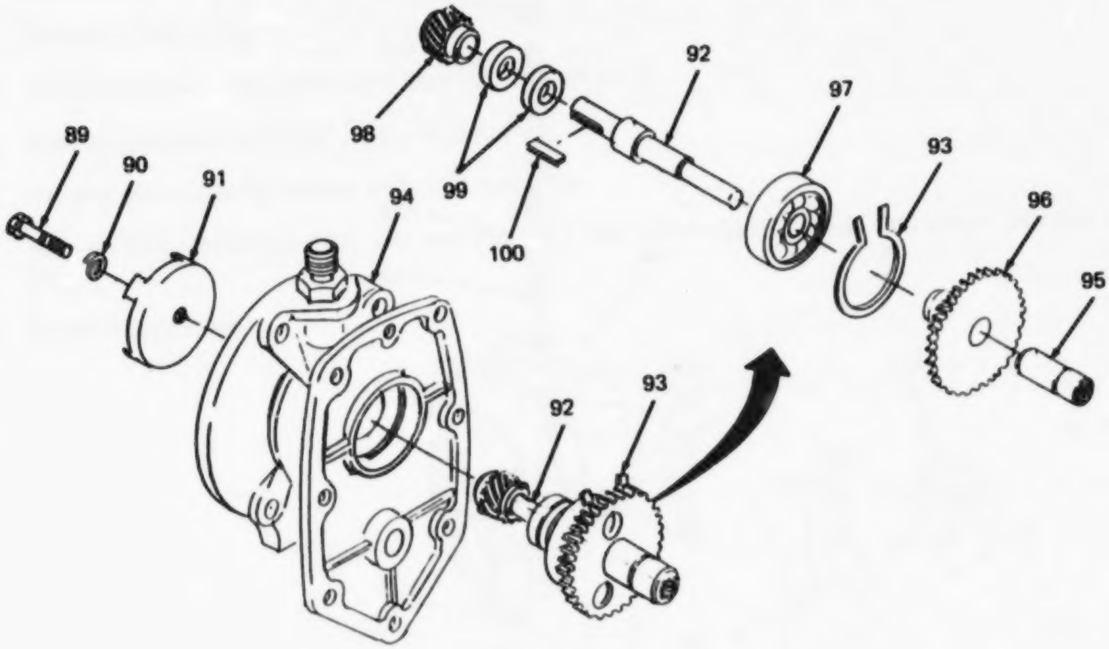
p. Remove screw (89) and lockwasher (90) securing drive coupling (91) to drive shaft (92).

q. Compress retaining ring (93) and press drive shaft (92) through front cover (94) and out of drive half coupling (95) and drive gear (96).

r. Remove retaining ring (93) and bearing (97).

s. Press tachometer drive gear (98) off drive shaft (92).

t. Remove oil seals (99) and coupling key (100) from drive shaft (92).

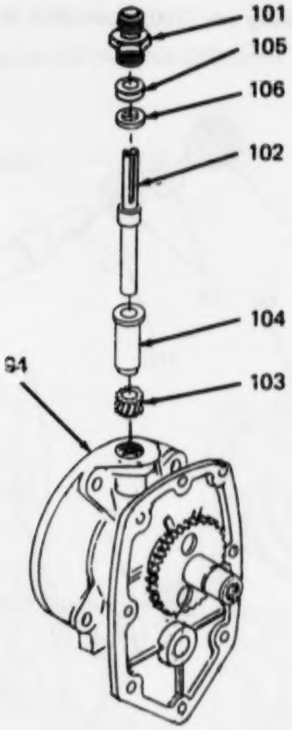


4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

u. Remove drive adapter (101) from drive cover (94).

v. Remove tachometer drive shaft (102), tachometer gear (103), tachometer drive bushing (104), tachometer seal (105), and tachometer seal spacer (106) from drive cover (94).

w. Press tachometer gear (103), tachometer seal (105), tachometer seal spacer (106), and tachometer drive bushing (104) from tachometer drive shaft (102).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

6 Remove fuel pump housing (5) as follows:

a. Remove three captive washer screws (107) securing actuator (108) and O-ring seals (109 thru 111) to pump housing (5).

b. Remove two drive pins (112) securing throttle shaft cover (113) to fuel pump housing.

c. Remove retaining ring (114) securing throttle shaft (115) and O-ring (116) to fuel pump housing (5).

d. Remove tamperproof ball (117) from throttle shaft (115).

e. Remove two setscrews (118) and throttle stop control (119).

f. Remove O-ring (120).

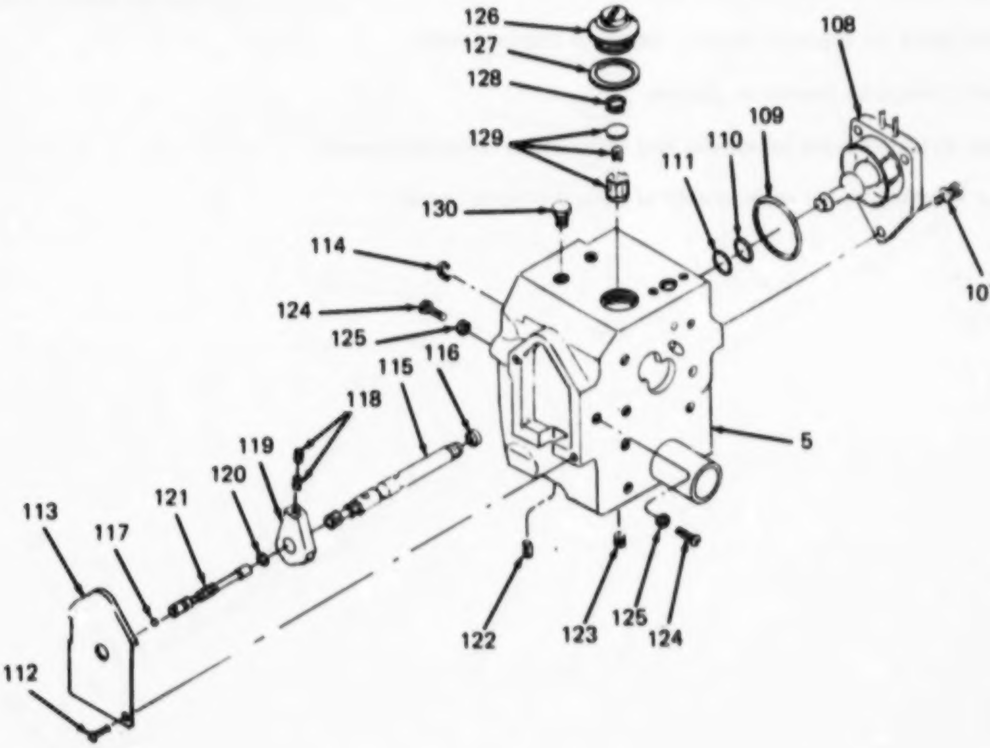
g. Remove fuel adjusting screw (121) from throttle shaft (115).

h. Remove governor barrel clip (122) and plug (123).

i. Remove stop adjusting screws (124) and nuts (125).

j. Remove filter screen cap (126), cap seal ring (127), filter spring (128), and fuel filter screen assembly (129).

k. Remove plug (130).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4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm²) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all fuel pump components thoroughly with dry cleaning solvent and dry with compressed air.

2 Inspect springs for bent or broken coils.

3 Inspect springs for proper free length and effective compressed length. Discard any springs not within tolerances.

4 Inspect shafts for securing nicks and scratches.

5 Inspect gears for cracked, broken, pitted, or chipped teeth.

6 Inspect O-rings for cracks or gouges.

7 Inspect threaded holes for cracks and damaged or stripped threads.

8 Repair is limited to the replacement of defective components.

4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

ASSEMBLY:

1 Install fuel pump housing (1) as follows:

a. Install plug (2).

b. Install fuel filter screen assembly (3), filter spring (4), cap seal ring (5), and fuel screen cap (6).

c. Install stop adjusting screws (7) and nuts (8).

d. Install governor barrel clip (9) and plug (10).

e. Install fuel adjusting screw (11) into throttle shaft (12).

f. Install O-ring (13).

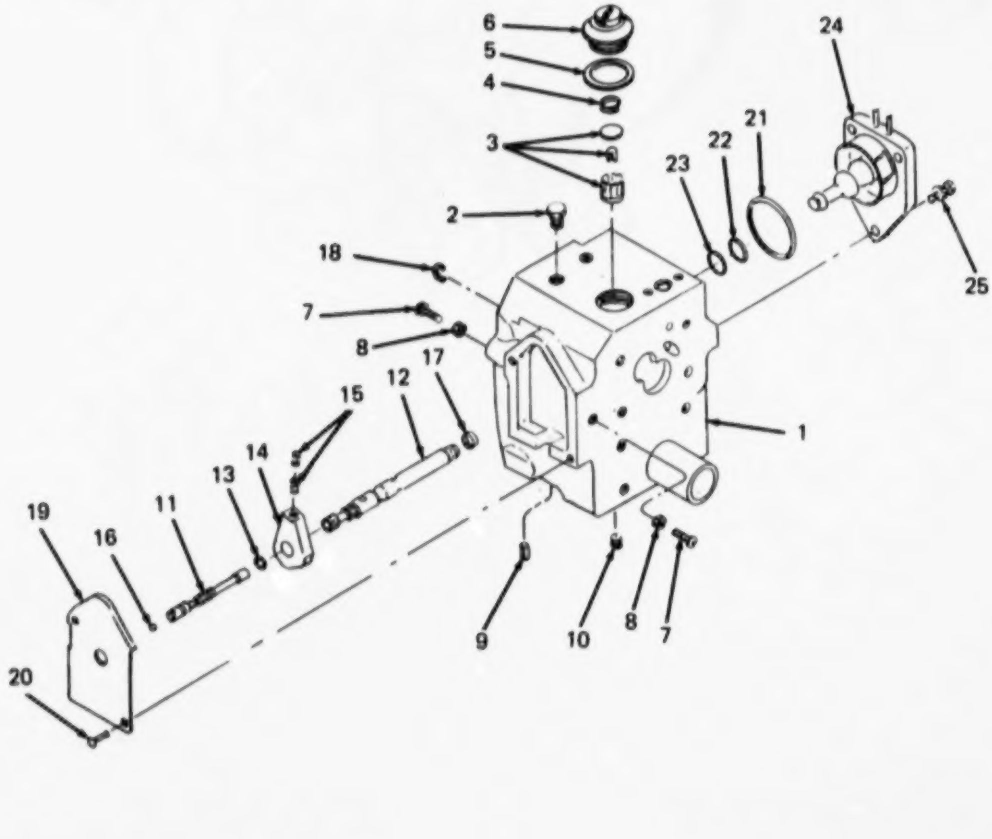
g. Install throttle stop control (14) and two setscrews (15).

h. Install tamperproof ball (16) in throttle shaft (12).

i. Install throttle shaft (12) and O-ring (17) into fuel pump housing (1) and secure using retaining ring (18).

j. Position throttle shaft cover (19) on fuel pump housing (1) and secure using two drive pins (20).

k. Position O-ring seals (21 thru 23) on actuator (24) and secure to fuel pump housing (1) using three captive washer screws (25).



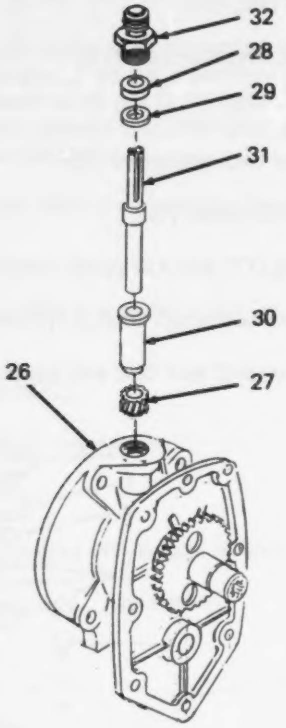
4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

2 Install main shaft cover and governor (26) as follows:

a. Press tachometer gear (27), tachometer seal (28), tachometer seal spacer (29), and tachometer drive bushing (30) on tachometer drive shaft (31).

b. Install tachometer drive shaft (31), tachometer gear (27), tachometer drive bushing (30), tachometer seal (28), and tachometer seal spacer (29) into main shaft cover (26).

c. Install drive adapter (32) into main shaft cover (26).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

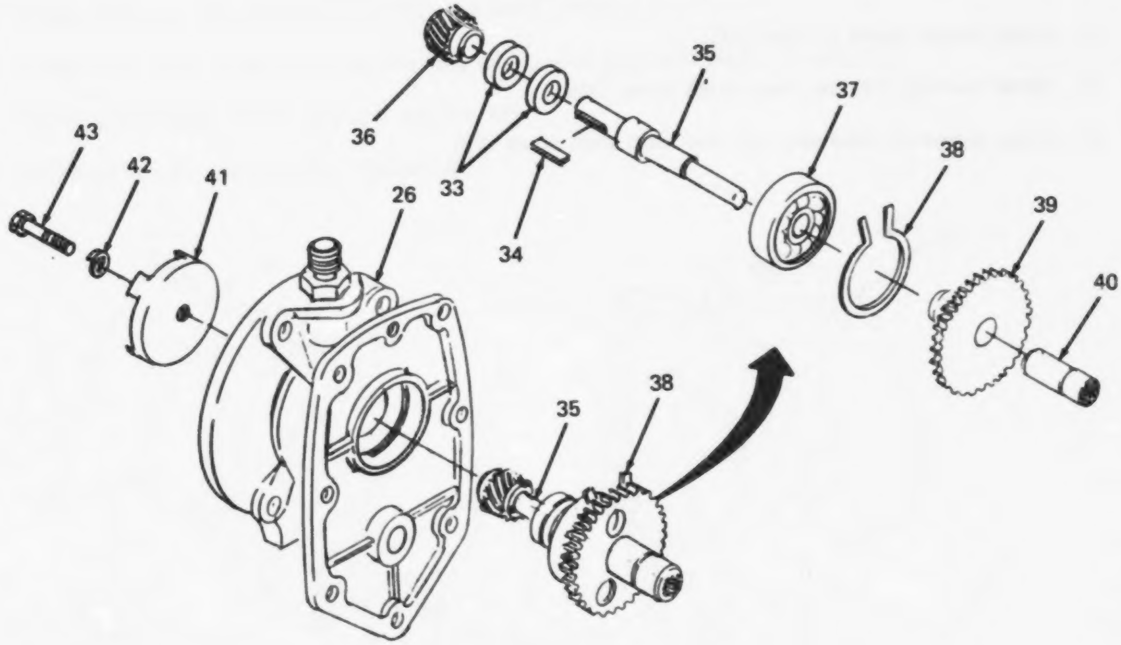
d. Install oil seals (33) and coupling key (34) onto drive shaft (35).

e. Press tachometer drive gear (36) onto drive shaft (35).

f. Install bearing (37) and retaining ring (38).

g. Compress retaining ring (38) and press drive shaft (35) through front cover (26) and into drive gear (39) and drive half coupling (40).

h. Install drive coupling (41) on drive shaft (35) and secure using lockwasher (42) and screw (43).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

i. Install weight carrier (44) onto shaft (45).

j. Install gear (46) onto shaft (45).

k. Install governor weights (47) onto weight carrier (44) using weight pins (48).

l. Install weight assist spring (49).

m. Install weight assist shims (50).

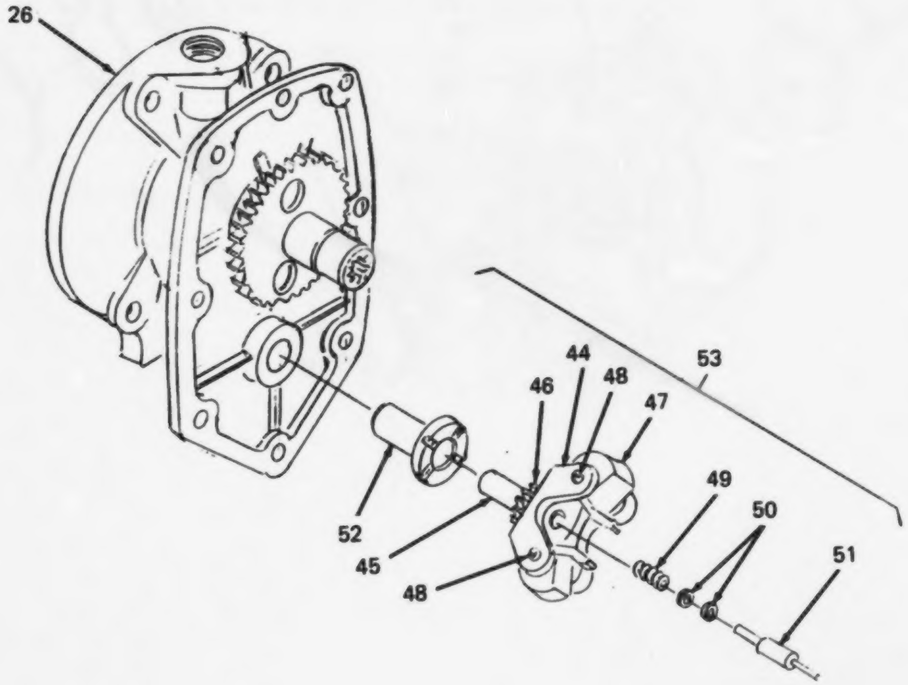
NOTE

Large end of plunger is installed first.

n. Install weight assist plunger (51).

o. Install bushing (52) into main shaft cover (26).

p. Install governor assembly (53) into main shaft cover (26).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

q. Install bypass valve shim (54) and torque spring (55) on governor plunger (56).

r. Install governor spacer (57), washer (58), and governor plunger driver (59) on governor plunger (56).

s. Install spring pack housing (60) and governor barrel (61) into pump housing (1).

CAUTION

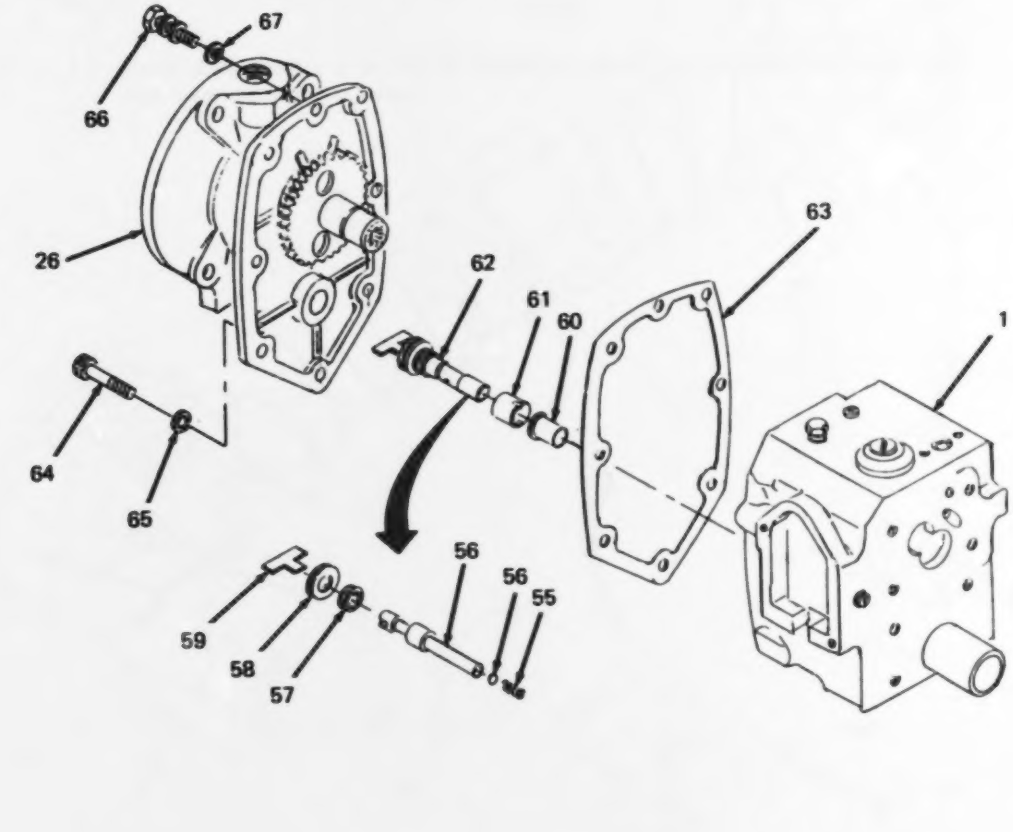
Parts must be submerged in diesel fuel and hands wet with diesel fuel before step t is performed to prevent damage to close tolerance parts.

t. Install governor plunger assembly (62) into pump housing (1).

u. Install main shaft cover and governor (26) and gasket (63) onto pump housing (1).

v. Install socket head screw (64) and washer (65).

w. Install six capscrews (66) and washers (67).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

3 Install governor spring pack (68) as follows:

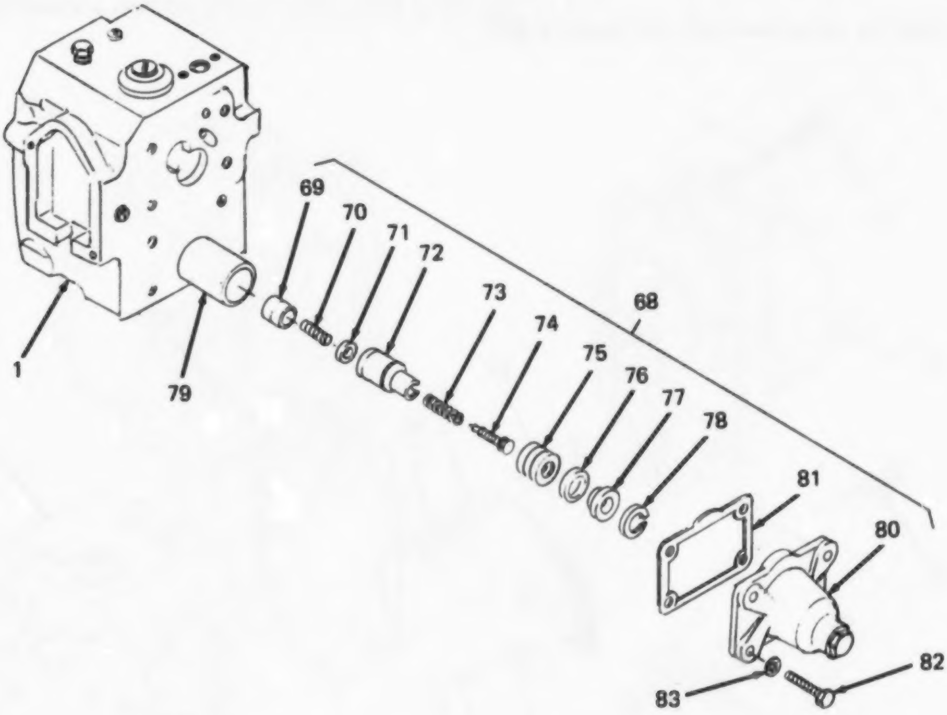
CAUTION

Parts must be submerged in diesel fuel and hands wet with diesel fuel before assembling governor spring pack to prevent damage to close tolerance parts.

a. Install idle spring plunger (69), spring (70), washer (71), spring guide (72), spring (73), screw (74), governor spring (75), shim (76), and retainer (77).

b. Install snap ring (78) on barrel (79).

c. Position spring pack cover (80) and gasket (81) on fuel pump housing (1) and secure using capscrews (82) and washers (83).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

4 Install gear pump assembly (84) as follows:

  a. Install adapter (85).

  b. Install dowel pin (86) if required.

  c. Install check valve (87).

  d. Install dowel ring (88).

  e. Install pressure valve (89).

  f. Install plugs (90).

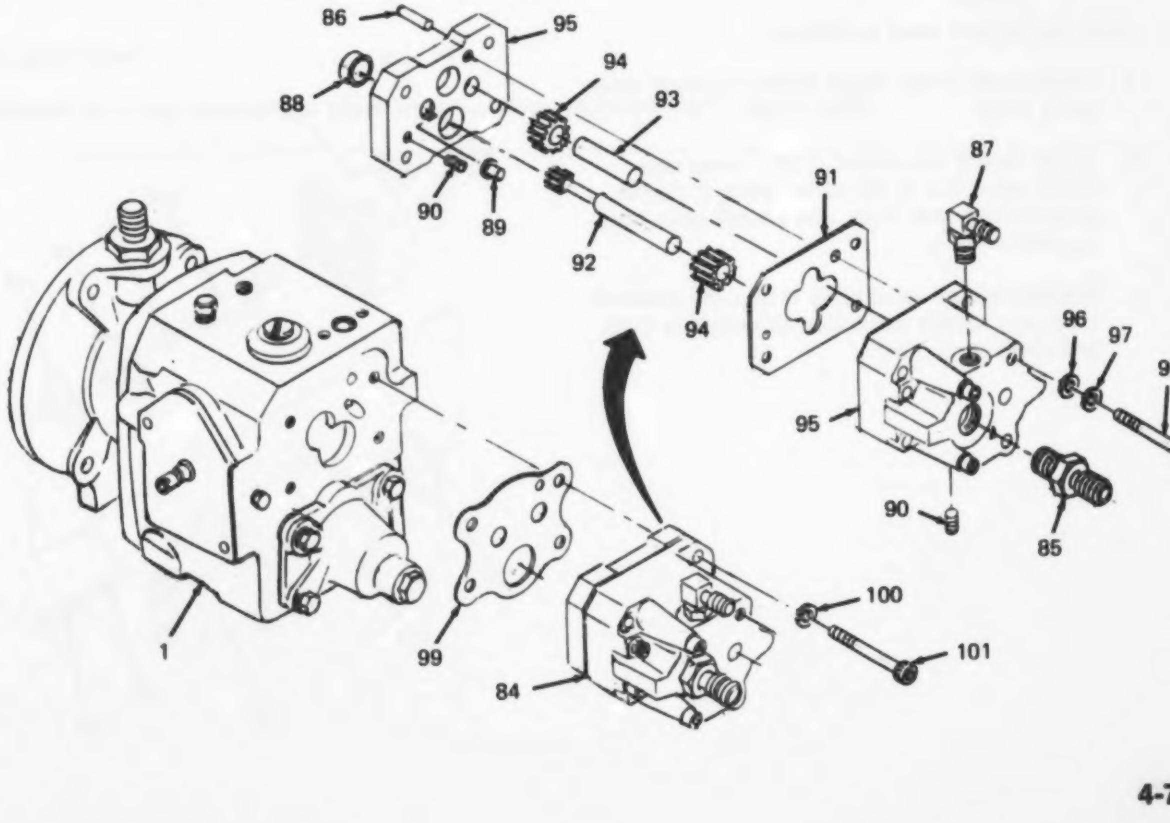
  g. Install gasket (91), shaft (92), shaft (93), and gears (94).

  h. Position cover and housing halves (95) together and secure using washers (96), lockwashers (97), and two socket head screws (98).

  i. Position gear pump assembly (84) and gasket (99) on fuel pump housing (1) and secure using four lockwashers (100) and socket head screws (101). Torque socket head screws 11 to 13 ft-lbs (15 to 18 N·m).

NOTE

Make sure gasket is in correct position and pump housing fuel holes align with gear pump fuel holes.



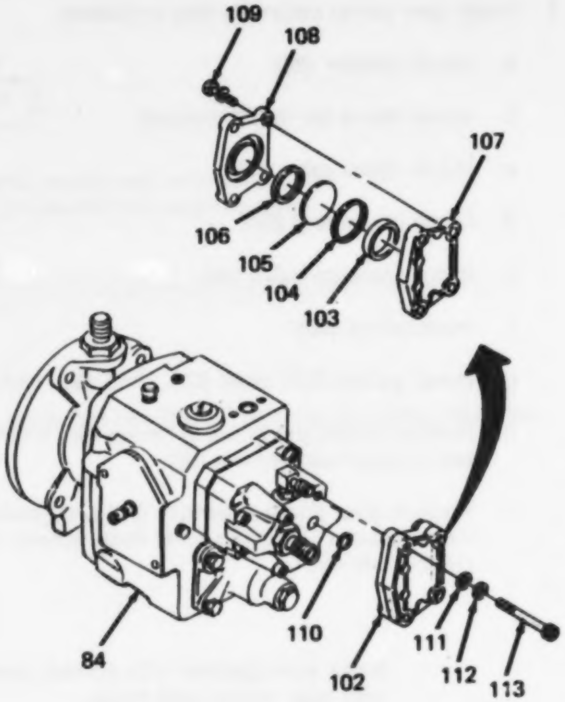
4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

5 Install fuel pump damper (102) as follows:

a. Install nylon washers (103), O-ring (104), diaphragm (105), and O-ring (106).

b. Secure damper plate (107) to damper body (108) using two captive washer screws (109). Torque screws to 11 to 13 ft-lbs (15 to 18 N•m).

c. Secure fuel pump damper (102) and seal (110) to gear pump (84) using flat washers (111), lockwashers (112), and socket head screws (113). Torque screws to 11 to 13 ft-lbs (15 to 18 N•m).

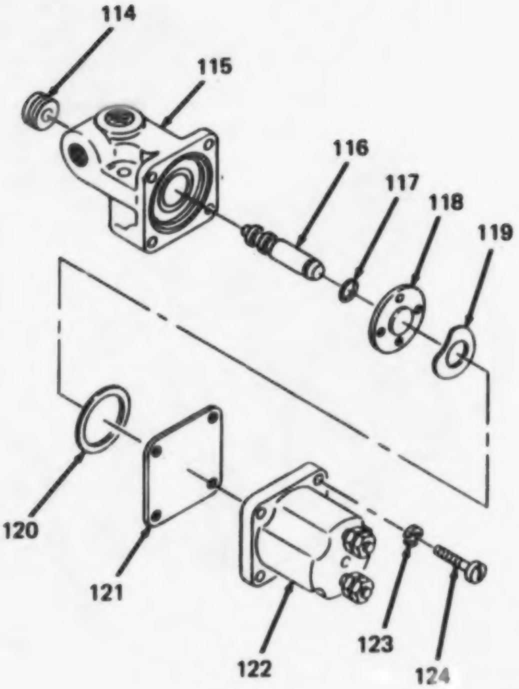


6 Install fuel shutoff valve as follows:

a. Insure knob (114) rotates freely in shutoff valve body (115).

b. Install shutoff valve shaft (116), O-ring seal (117), valve disc (118), valve spring (119), rectangular ring seal (120), and shutoff valve housing shield (121).

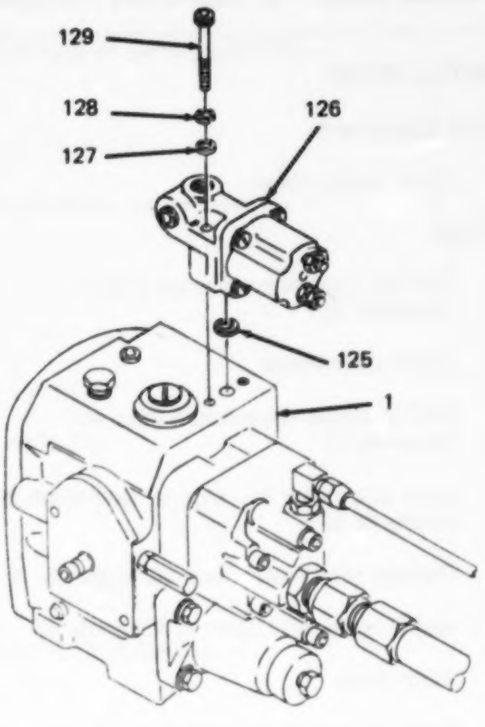
c. Position shutoff valve body (115) onto solenoid (122) and secure using four lockwashers (123) and capscrews (124).



4-9. FUEL PUMP ASSEMBLY REPAIR/CALIBRATE (CONT)

d. Install rectangular ring seal (125).

e. Position fuel shutoff valve (126) on fuel pump housing (1) and secure using washers (127), lockwashers (128), and two socket screws (129).



CALIBRATION:

Calibrate fuel pump assembly in accordance with fuel pump test stand requirements.

4-10. LUBE OIL PUMP ASSEMBLY REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Repair/Assembly

INITIAL SETUP

Test Equipment

Valve spring tester

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Depth micrometer

DFC pressure valve fixture (Item 43, Appendix B)

Light duty puller kit - bypass valve (Item 32, Appendix B)

Outside micrometer (Item 36, Appendix B)

Inside micrometer (Item 4, Appendix B)

Arbor press

Gear and spacer mandrel (Item 30, Appendix B)

Bushing mandrel

Rubber Hammer

Torque Wrench (Item 2, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Emery cloth (Item 2, Appendix C)

Lubricating oil (Item 22, Appendix C)

Antiseizing tape (Item 31, Appendix C)

Shim stock

Gaskets

O-rings

Lint free rags (Item 19, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 3-31	Lube oil pump assembly removed

General Safety Instructions

Well ventilated area for cleaning

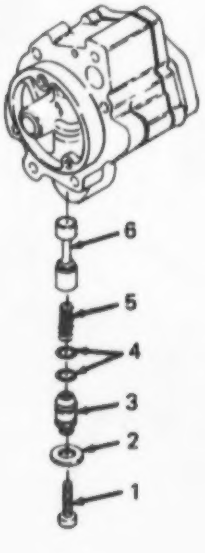
DISASSEMBLY:

WARNING

Push in on capscrew as it is being removed to prevent pressure regulator parts from springing out and possibly causing personal injury.

1 Unscrew and remove capscrew (1), pressing in on capscrew to relieve spring compression gradually.

2 Remove washer (2), retainer plug (3) with two O-rings (4), pressure regulator spring (5), and pressure regulator plunger (6).



4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

3 Remove two capscrews (7), lockwashers (8), cover plate (9), and gasket (10).

4 Remove four capscrews (11) securing lube oil pump cover (12) to lube oil pump body (13).

5 Remove lube oil pump cover (12) with gasket (14).

NOTE

Hit the cover lightly with a rubber hammer to help remove cover from dowel (15) in pump body.

6 Remove drive gear (16) from drive shaft (17), using gear puller.

7 Remove key (18) from drive shaft (17).

8 Push drive shaft (17) with lube oil pump gear (19) out of pump body (13).

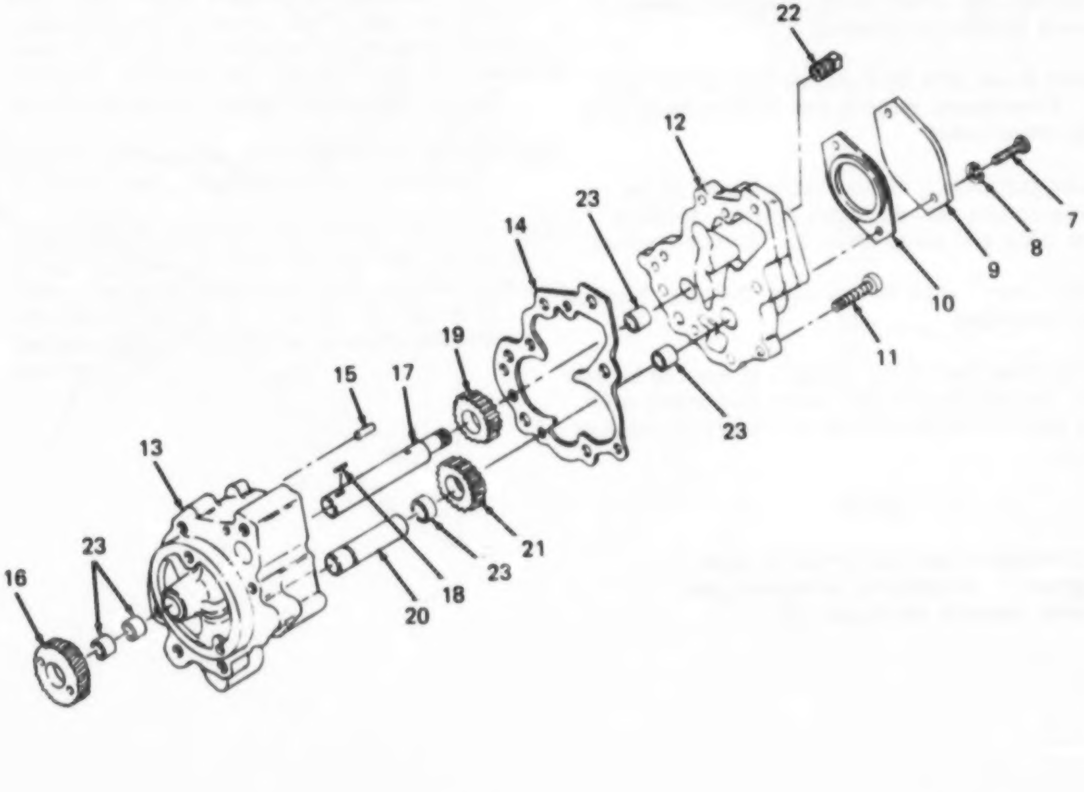
9 Push idler shaft (20) with lube oil pump gear (21) out of pump body (13).

10 Remove lube oil pump gear (19) from drive shaft (17) using gear puller.

11 Remove lube oil pump gear (21) from idler shaft (20).

12 Remove pipe plug (22) from lube oil pump cover (12).

13 Remove bushings (23) using arbor press and mandrel as required for replacement.



4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

CLEANING/INSPECTION:

WARNING

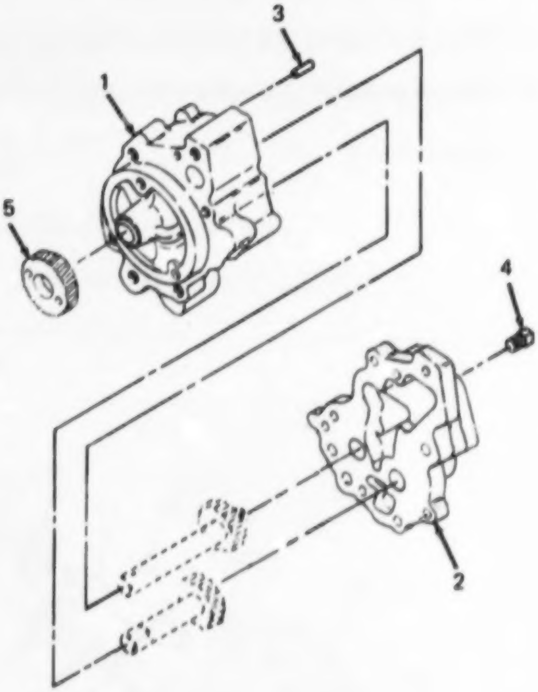
Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all parts with dry cleaning solvent to remove all traces of grease and oil.

2 Dry all parts with compressed air.

3 Blow out oil passages with compressed air.



4 Clean all gasket material from pump body (1) and pump cover (2). Check gasket surfaces for scratches, wear, or damage. Smooth out scratches or damage with emery cloth or replace gaskets if damage cannot be corrected.

5 Inspect dowel pins (3) in pump body (1) for damage. If necessary, remove and replace dowel pins using dowel puller.

6 Inspect pump body (1) and pump cover (2) for breaks, cracks, and damaged threads. Replace pump body and pump cover if broken or cracked.

7 Inspect pipe plug (4) for damaged threads. Replace plug if damaged.

8 Inspect drive gear (5) for pitting and worn or broken teeth. Replace gear if gear teeth have pitting over more than 1/4 width of tooth or if teeth are worn or broken.

NOTE

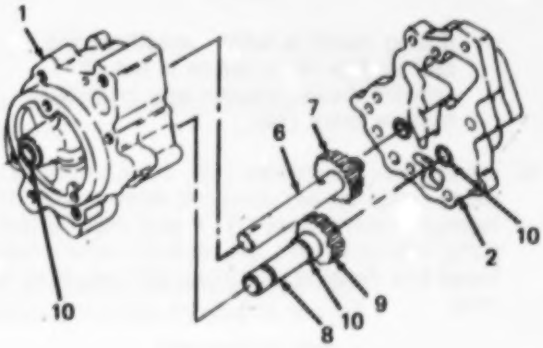
If backlash test performed in paragraph 3-38 indicates excessive gear wear, replace drive gear (5).

4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

9 Inspect drive shaft (6) and lube oil pump driven gear (7) for damage and worn or broken gear teeth. Gears must be replaced if pitting is present over more than 1/4 width of teeth. If necessary, replace drive shaft or gear using arbor press.

10 Inspect idler shaft (8) and lube oil pump idler gear (9) for damage and worn or broken gear teeth. Gears must be replaced if pitting is present over more than 1/4 width of teeth. If necessary, replace idler shaft or gear.

11 Inspect bushings (10) in pump body (1), pump cover (2), and pump idler gear (9) for excessive wear or discoloration due to overheating or seizing. If necessary, replace bushing with arbor press and bushing mandrel.



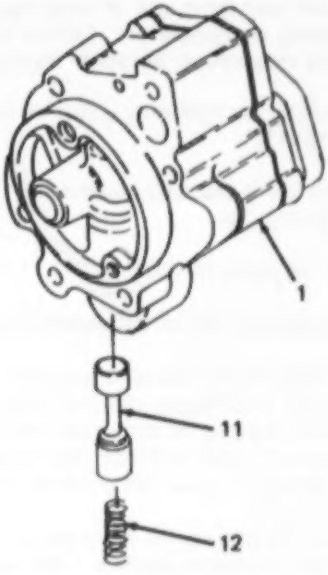
NOTE

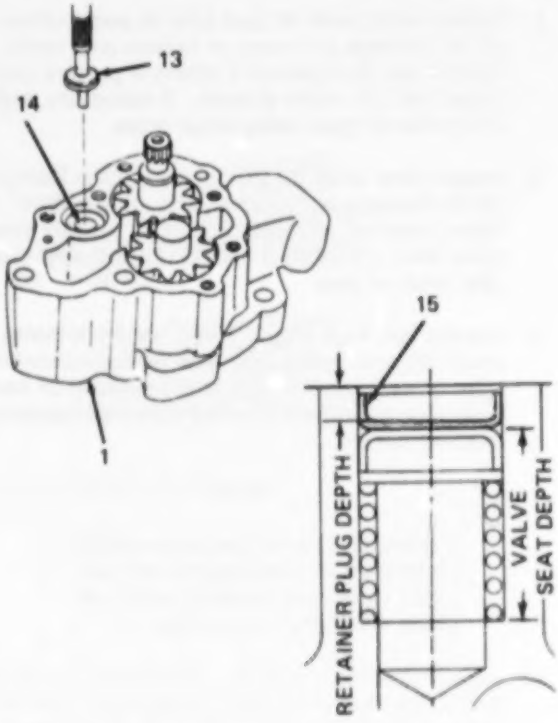
If drive shaft and clearance check performed in paragraph 3-30 indicates excessive bushing wear, replace drive shaft bushings.

12 Inspect pressure regulator plunger (11) to see if it is bent. Try plunger in pressure regulator bore in oil pump body (1) to ensure that it does not bind. Inspect plunger for scratches or scoring. Replace plunger if it is bent, binds in the bore, or if scratches are present which can be felt with a fingernail.

13 Inspect pressure regulator spring (12) for damaged or broken coils. Replace spring if damaged.

14 Using valve spring tester, compress pressure regulator spring (12) to a height of 1.820 inches (46.23 mm). The force required to compress the spring to this height must be 22 to 26 lbs (98 to 116 N). Replace spring if it does not conform with this standard.





NOTE

If plug depth is within specifications and engine oil pressure is out of specifications, remove and inspect bypass valve (14).

15 Using depth micrometer (13), measure the installed depth of the bypass valve (14) retainer plug (15), located in pump body (1). If plug depth is less than 0.255 inch (6.48 mm) use pressure valve fixture to install it to depth of 0.255 to 0.275 inch (6.48 to 6.98 mm).

WARNING

Hold in on retaining plug to keep it from springing out of bore due to spring compression. Failure to do this may cause personal injury.

16 If required, use light duty puller kit to remove retaining plug (15).

17 Remove valve disc (16), washer (17), and bypass valve spring (18).

18 Inspect all parts for damage.

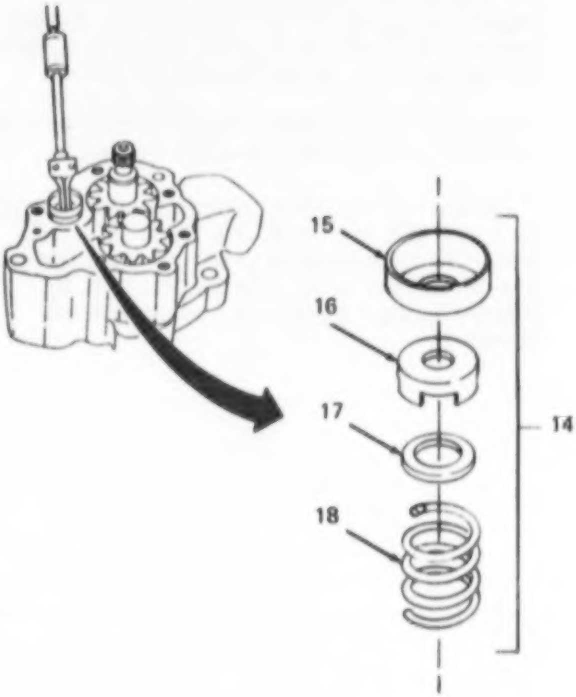
19 Inspect spring (18) for damaged or broken coils.

20 Using valve spring tester, compress bypass valve spring (18) to a height of 1.145 inches (29.0 mm). The force required to compress the spring to this height must be 59 to 72 lbs (260 to 320 N). Replace spring if it does not conform to this standard.

21 Measure bypass valve seat depth in pump body (1). Maximum allowable depth is 1.840 inches (46.73 mm). If depth exceeds this limit, replace pump body.

22 Measure outside diameter of drive shaft and idler shaft. Replace shaft if outside diameter is under 0.6145 inch (15.608 mm).

23 Measure inside diameter of bushings. Replace bushing if inside diameter exceeds 0.6185 inch (15.710 mm). Use bushing mandrel and arbor press to remove bushing.



4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

REPAIR/ASSEMBLY:

NOTE

Repair of lube oil pump is limited to replacement of damaged or worn parts.

1 Install bypass valve (1) as follows:

NOTE

The DFC pressure valve fixture consists of a locating plate and reversible mandrel. The plate installs over the bypass valve bore, located in the oil pump body, with two capscrews.

a. Install locating plate (2) on pump body (3) using two 5/16-18UNC x 1-1/4-inch capscrews (4) screwed in handtight.

b. Install large diameter end of mandrel (5) through locating plate and into bypass valve bore.

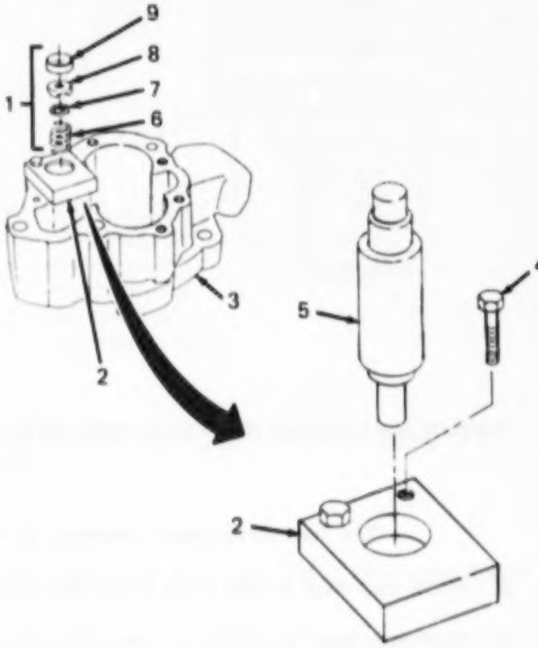
c. Tighten two capscrews (4) and remove mandrel (5).

d. Install bypass valve spring (6), washer (7), valve disc (8), and retaining plug (9) through locating plate (2) into valve bore being sure that prongs on disc face down and cupped side of retaining plug is up.

e. Install small end of mandrel (5) in bore of locating plate (2).

f. Press mandrel (5) with arbor press until large diameter of mandrel is against locating plate (2).

g. Remove locating plate (2).



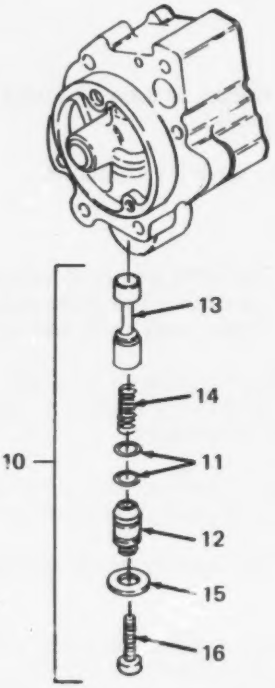
4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

2 Install pressure regulator (10) as follows:

a. Install two new O-rings (11) on retainer plug (12) and lubricate O-rings with lubricating oil.

b. Install plunger (13), spring (14), retainer plug (12), washer (15), and capscrew (16).

c. Tighten capscrew (16) to 20 ft-lbs (25 N•m) torque.



3 Replace any bushings which were removed due to excessive wear or damage as follows:

NOTE

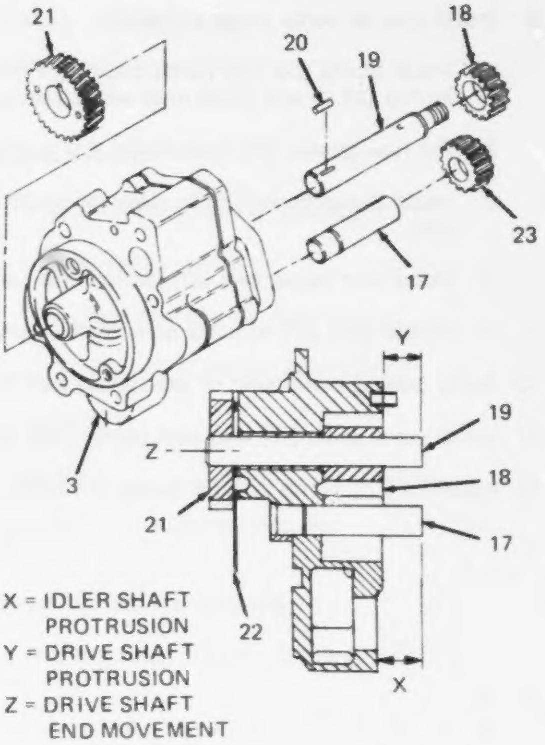
The two drive shaft bushings in the pump body must be replaced as a pair.

a. Press bushings in with arbor press and bushing mandrel.

b. Bushings must be driven in even with or to a maximum of 0.020 inch (0.51 mm) below surface of pump body, pump cover, or idler gear.

c. Measure inside diameter of bushings and bore out to 0.6165 to 0.6175 inch (15.659 to 16.684 mm).

4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)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Z
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21
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22
X
X = IDLER SHAFT PROTRUSION
Y = DRIVE SHAFT PROTRUSION
Z = DRIVE SHAFT END MOVEMENT

4 Install idler shaft as follows:

  a. Apply a coat of lubricating oil to large diameter portion of idler shaft (17).

  b. Press large diameter end of idler shaft (17) into bore in pump body (3), using arbor press with gear and spacer mandrel.

  c. Check that idler shaft (17) protrudes between 0.720 and 0.740 inch (18.29 and 18.80 mm) from inside flange of pump body.

5 Install driven gear (18) to drive shaft (19) as follows:

  a. Apply a coat of lubricating oil to inside diameter of gear (18).

  b. Press gear (18) onto drive shaft (19), using arbor press with spacer mandrel.

6 Install drive shaft (19) as follows:

  a. Install drive shaft (19) from gear pocket side of pump body (3), into bore in pump body (3).

  b. Install key (20) into keyway in drive shaft (19).

  c. Apply a coat of lubricating oil to inside diameter of drive gear (21).

  d. Place 0.012-inch (0.30 mm) shim (22) between back side of drive gear (21) and front of pump body and use arbor press to press drive gear onto drive shaft (19).

  e. Remove shim (22).

  f. Check that drive shaft (19) protrudes between 0.855 and 0.875 inch (21.72 and 22.22 mm) from inside flange of pump body (3).

  g. Check that drive shaft end movement is between 0.002 and 0.008 inch (0.05 and 0.20 mm).

7 Apply lubricating oil to inside diameter of idler gear (23) and install idler gear onto idler shaft (17).

8 Apply lubricating oil to gears, bushings, and shafts.

4-10. LUBE OIL PUMP ASSEMBLY REPAIR (CONT)

9 Install lube oil pump cover as follows:

  a. Install dowel (24) into pump body (3) if removed. The dowel pin must protrude between 0.990 and 1.010 inches (22.15 and 25.65 mm) above pump body surface.

  b. Put new gasket (25) over dowel (24) and line up with bolt holes in pump body (3).

  c. Install pump cover (26) to pump body (3), and hit cover lightly with rubber hammer to push onto dowel (24).

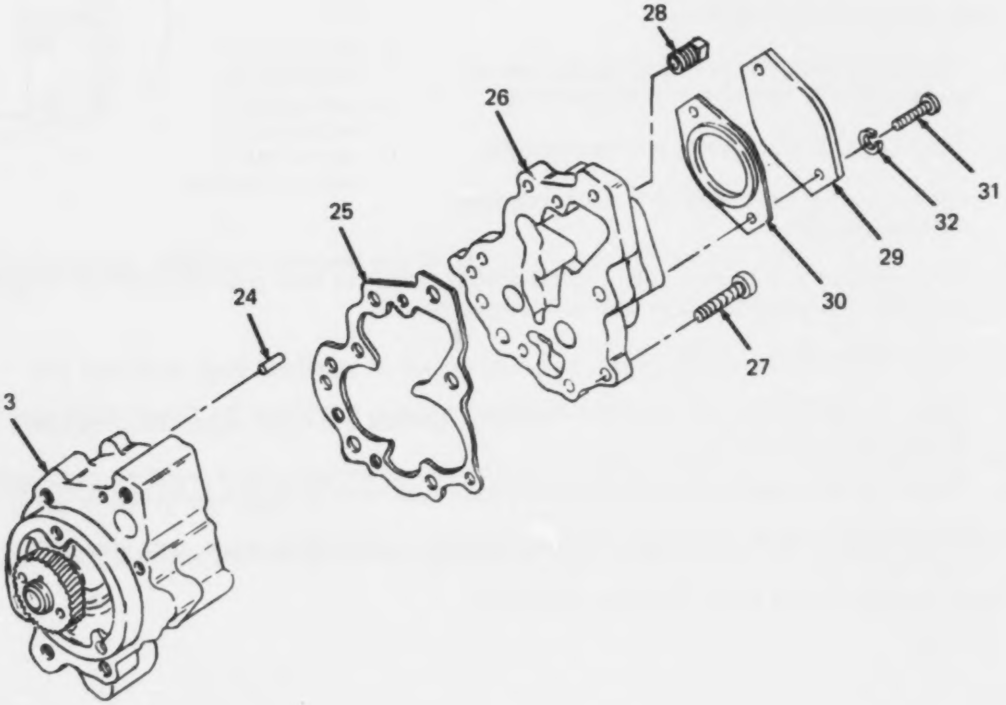
  d. Install four capscrews (27) and captive washers and tighten to 30 to 35 ft-lbs (40 to 47 N•m) torque.

  e. Rotate gear (21) to make sure shaft is turning freely in pump.

10 Apply sealing compound or antiseizing tape to threads of pipe plug (28) and install plug to pump cover (26).

11 Install cover plate (29) with new gasket (30), and secure with capscrews (31) and lockwashers (32).

12 Install lube oil pump in accordance with paragraph 3-30.



4-11. INJECTOR REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection/Repair c. Assembly

INITIAL SETUP

Tools

- Tool kit, general mechanics (Item 1, Appendix B)
- Crows foot wrench
- Depth micrometer
- Spring tester
- Cup retainer wrench
- Magnifying glass

Materials/Parts

- Dry cleaning solvent (Item 30, Appendix C)
- Pigment (Item 24, Appendix C)
- Lapping and grinding compound (Item 18, Appendix C)

Materials/Parts

- Diesel fuel oil (Item 11, Appendix C)
- Mineral spirits
- Lint free rags (Item 19, Appendix C)
- Lubricating oil (Item 22, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 3-35	Injectors removed

General Safety Instructions

Well ventilated area for cleaning

DISASSEMBLY:

1 Install injector body wrench in vise.

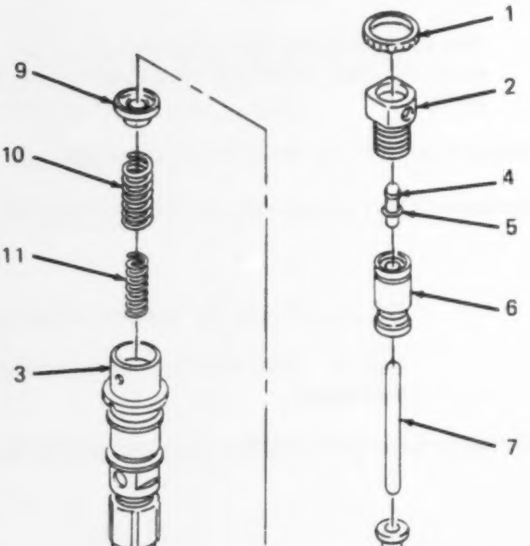
2 Slide flat, machined areas in fuel supply groove of injector into body wrench.

3 Using crowfoot wrench, remove locknut (1).

4 Remove injector stop screw (2) from injector adapter (3).

5 Remove link (4), retainer clip (5), tappet (6), injector plunger link (7), plunger (8), and injector spring retainer (9) from injector adapter (3).

6 Remove compression springs (10 and 11) from injector adapter.



4-11. INJECTOR REPAIR (CONT)

7 Reverse position of injector in injector body wrench so that injector cup retainer (12) faces up.

CAUTION

Do not remove cup retainer with injector in horizontal position or with cup retainer facing down. The barrel and check ball will fall out.

8 Using cup retainer wrench, loosen injector cup retainer (12).

9 Remove injector from injector body wrench.

10 Hold injector with cup retainer (12) up and screw retainer off injector adapter (3). Remove injector cup (13).

NOTE

Check ball will fall out when barrel is removed from adapter.

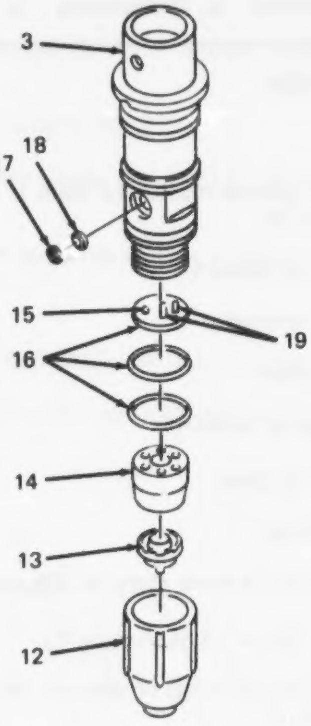
11 Hold barrel (14) against injector adapter (3) and turn injector so that barrel faces down. Remove barrel (14) and check ball (15).

NOTE

The injector barrel and plunger are class fit. Do not interchange these parts.

12 Remove and discard three O-ring seals (16).

13 Remove screen retainer (17) and filter screen (18).



NOTE

Do not remove the injector oriface plug from fuel inlet counterbore.

Roll pins (19) need not be removed from injector adapter (3) unless damaged.

14 Do not remove injector orifice plug and gasket located behind filter screen (18).

4-11. INJECTOR REPAIR (CONT)

CLEANING/INSPECTION/REPAIR:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Check and make note of injectors having carbon deposits at tip of plunger.

2 Clean injector parts of any carbon varnish using dry cleaning solvent.

NOTE

Ultrasonic cleaning is recommended for barrel, plunger, and cup.

3 Neutralize the solvent after cleaning by dipping the parts in mineral spirits and dry with compressed air.

CAUTION

Do not use drills or other instruments to clean injector cup holes. This can alter the hole size. Wires may be used if wire is a smaller size than spray hole. Never use a wire brush or crocus cloth to clean cup tip area.

4 Clean injector cup holes using wire of smaller diameter than spray holes.

4-11. INJECTOR REPAIR (CONT)

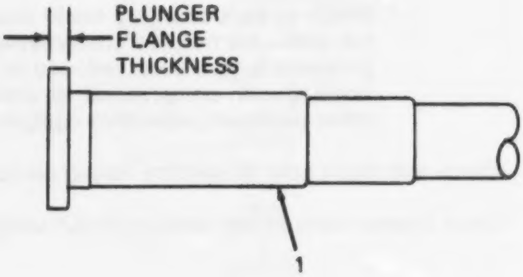
CAUTION

After cleaning injector parts, a clean area, free of grease and dirt, must be provided for inspection procedures. Most injector failures are caused by dirt.

5 Place all injector parts on lint free towels on work bench area for inspection.

6 Inspect plunger (1) as follows:

a. Excessive wear or fretting may be found on spring retainer contact area of plunger flange. Replace plunger and barrel assembly if plunger flange is less than 0.144 inch (3.66 mm) thick.



b. Check closely for metal seizure. This is the only true indication of scuffing or scoring.

c. Bright spots or surface disruption at top of plunger machined area, on the opposite side at the bottom of plunger, or at mid-point, usually are normal results of rocker lever thrust action. Unless metal is displaced or wear is measurable at these points, the plunger can be reused. If barrel and plunger do not pass a leakage test a new barrel and plunger assembly must be installed.

d. Narrow streaks running the length of the plunger usually are the result of varying thicknesses of penetrant treatment used to prevent rusting. The plunger may be reused unless surface disruption in metal is evident.

e. Carbon deposits on the small diameter near tip of plunger may be caused by injector timing being set too slow.

NOTE

This condition, if present, will have been observed and noted before cleaning.

4-11. INJECTOR REPAIR (CONT)

7 Inspect injector barrel as follows:

a. Inspect injector barrel plunger bore for scoring or corrosion. If injector will pass leakage test, the barrel is usable. If leakage is too high, barrel and plunger must be replaced.

b. Use a strong magnifying glass to check for burrs, carbon, and distorted radii in the orifice. When metering orifice is damaged, the injector will not function properly. Do not attempt cleaning with wires, plug gauges, etc. Use solvent cleaners.

c. Check fuel passage plugs for looseness and the barrel for cracks.

d. Check injector barrel surfaces for mutilation.

8 Inspect check ball and barrel check ball seat as follows:

a. Replace check ball if worn or damaged.

b. Inspect check ball seat for damage.

c. If damage is found, the check ball seat can be improved by lapping a ball to the seat as follows:

(1) Weld check ball to end of a small rod.

(2) Use 600 grade paste lapping compound to lap the seat.

(3) Clean lapping compound out of barrel.

d. Inspect depth of check ball seat.

(1) Install check ball in barrel.

(2) Using depth micrometer, check that depth of ball does not exceed 0.055 inch (1.40 mm). If it does, barrel and plunger must be replaced.

e. Perform leakage test to determine if check ball and check ball seat form an adequate seal. Replace barrel and ball if leakage exceeds recommended limits.

4-11. INJECTOR REPAIR (CONT)

9 Inspect injector cup by comparing with new cup. Discard cup if any of the following conditions exist:

a. Abresive wear: This wear can begin internally, therefore both interior and exterior surfaces must be inspected.

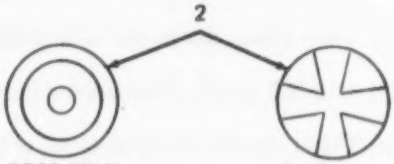
b. Corrosion and erosion damage and the effect of excessive heat: This condition usually results from high water, acid or sulphur content in the fuel or from overloaded operating conditions. Slight erosion on outside of cup which has not changed hole size can be tolerated. In cases of major damage, replace cup.

c. Enlarged or distorted spray holes caused either by high operating hours or by improper cleaning techniques such as wire brushing or cleaning holes with drill bit.

NOTE

The plunger must seat in the cup from 1/4 of the upper cone area to the full cone area. Reject a cup that seats in lower 1/4 cup tip area. If a cup seats in the tip area, it must seat more than 1/2 of cone area to be accepted.

d. Bad seating pattern of plunger to cup: Inspect cup (2) for plunger seat pattern. Select a new plunger and coat tip with prussian blue. Insert plunger in cup and rotate 90 degrees. If plunger seat covers a 40 percent continuous area around cup cone or plunger bore, it is possible the cup may be reused. The cup must also pass cup-to-plunger leak test.



GOOD SEAT CONTINUOUS PATTERN

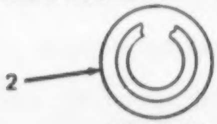
BAD SEAT STAR PATTERN

e. Mutilation and flatness of injector cup barrel seating surface:

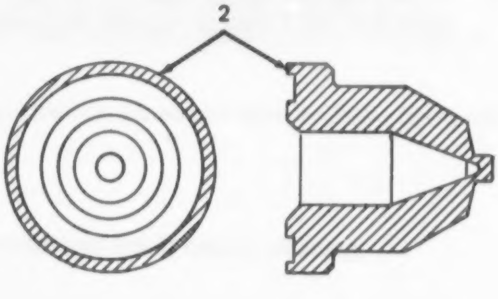
(1) Visually inspect area shown blackened in figure for mutilation.

(2) Use a flat steel plate (preferably a lapping plate) and bluing to check for surface flatness.

(3) If mutilation or unevenness is found, repair or replace barrel.



BAD SEAT BROKEN PATTERN



4-11. INJECTOR REPAIR (CONT)

10 Inspect injector adapter as follows:

a. Check balance orifice for burrs or other obstructions.

b. Inspect both fuel passages to be certain they are open.

c. Inspect cup retainer threads for damage.

d. Check O-ring areas for nicks or burrs which will damage O-rings during installation.

e. Inspect barrel mating surface for nicks or burrs. If damage is found, lap to repair.

f. Check inside diameter behind adjustable orifice plug. If a burnishing needle that is too long is used, there will be a hole through the adapter. This will cause lubricating oil dilution.

11 Inspect cup retainer as follows:

a. Inspect threads for damage.

b. Check outside cone area for nicks and burrs that could prevent proper seating with the sleeve in the head.

c. Inspect inside of cone area on cup seating ledge for nicks or burrs that could prevent the cup from seating.

12 Inspect compression springs as follows:

a. Check spring for excessive wear or mutilation.

b. Test spring tension on spring tester. This spring tester is capable of very accurate measurements of spring lengths and applied load by means of standards and dial indicator gauge.

c. If injector springs compress to the given dimensions, less than the minimum acceptable worn limit, the spring must be discarded.

Load Required to Compress Spring to Length

	Approx. Free Length Inch (mm)	Length Inch (mm)	Minimum lb. (kg)	Maximum lb. (kg)
Small Compression Spring	1.490 (37.8460)	1.055 (26.80)	85.70 (38.8)	95.70 (43.4)
Large Compression Spring	1.506 (38.2524)	0.930 (23.62)	110.0 (49.8)	126.0 (57.1)

d. Check squareness of spring used in top stop injector.

(1) Place spring in V-block and stand assembly up on a flat surface.

(2) Maintain contact between coils of the spring and the V-block and baseplate while rotating the spring. Measure flatness of the ground ends (approximately 270 degrees) with dial indicator.

(3) Turn spring over in V-block and check opposite end using the procedure as outlined in step (2).

4-11. INJECTOR REPAIR (CONT)

NOTE

The amount must not exceed 0.016 inch (0.41 mm) on each end.

Springs which do not meet this standard must be discarded.

13 Inspect spring retainer. Replace retainer if it is worn more than 0.003 inch (0.076 mm) deep.

14 Inspect plunger links for wear. If wear can be seen or felt, it shall be considered excessive and link should be replaced.

15 Inspect filter screen for clogging or deterioration of screen. Replace filter screen if it is worn through or torn.

16 Inspect roll pins in injector adapter for damage. Replace roll pins if damaged.

ASSEMBLY:

CAUTION

Be certain all mating surface parts are clean and free of burrs or other imperfections which might result in incorrect flow or torque.

1 Drop check ball (1) into recess in barrel (2).

2 Hold barrel (2) with check ball up and install injector adapter (3) on barrel using two roll pins (4) as locators.

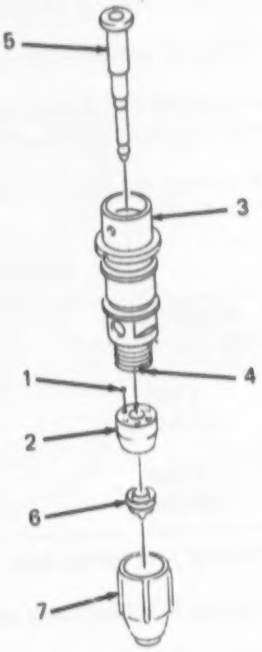
3 Immerse plunger (5) in clean diesel fuel oil and install in adapter (3) without spring.

4 Turn adapter (3) so that barrel (2) is up and place injector cup (6) on barrel.

5 Lubricate cup flange contact area of cup retainer (7) with lubricating oil and assemble to adapter (3). Screw retainer down hand tight.

6 Install flat machined areas in fuel supply groove of injector adapter (3) into injector body wrench.

7 Using cup retainer wrench, tighten cup retainer to required torque 57 ft-lb (77 N•m).



4-11. INJECTOR REPAIR (CONT)

8 To check plunger alignment by hand proceed as follows:

WARNING

Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

a. Remove plunger (5) and coat with clean diesel fuel oil.

b. Install injector plunger extension tool on plunger (5).

c. Hold injector adapter (3) in a vertical position with cup down and allow plunger to drip a few drops of oil into the cup.

d. Insert plunger (5) about 0.5 inch (12.7 mm) into barrel.

e. Push plunger (5) in with palm of hand to seat plunger in cup, and rotate 90 degrees while holding plunger against cup seat.

f. Hold injector adapter (3) with cup up and lift quickly. If plunger (5) slides out, alignment is correct.

g. If plunger (5) does not slide, try test again after coating plunger tip with diesel fuel oil. If plunger still does not slide out, injector must be reassembled.

9 Install inner spring (7), outer spring (8), spring retainer (9), and plunger (5) into injector adapter (3).

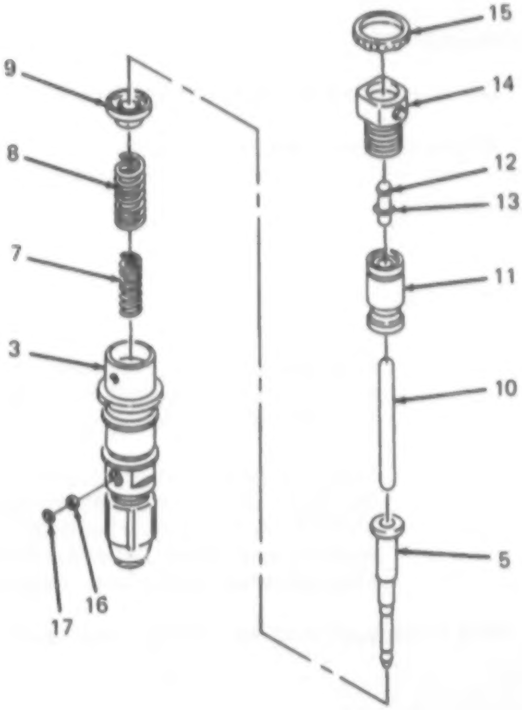
10 Install injector plunger link (10), tappet (11), and link (12) with retainer clip (13) into injector adapter (3).

11 Install injector stop screw (14) and locknut (15) on injector adapter (3).

12 Install filter screen (16) and screen retainer (17) into injector adapter (3).

13 Test and adjust injectors in accordance with paragraph 3-34.

14 Install injectors in accordance with paragraph 3-34.



-12. CYLINDER HEAD ASSEMBLY REPAIR

his task covers: a. Disassembly b. Cleaning c. Inspection d. Repair

NITIAL SETUP

ools

Tool kit, general mechanics (item 1, Appendix B)

Inside micrometer (Item 4, Appendix B)

Bore gauge

Valve spring compressor

Reamer (Item 3, Appendix B)

Milling machine

Valve grinding machine

Orbital sander

Rubber hammer

laterials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Antiseizing tape (Item 31, Appendix C)

Materials/Parts

Wire brush

Lapping and grinding compound (Item 18, Appendix C)

Dye penetrant

Prussian blue (Item 24, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 3-36	Cylinder head assembly removed

General Safety Instructions

Well ventilated area for cleaning

ISASSEMBLY:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

Prior to disassembling the cylinder head, steam clean and dry assembly with compressed air.

NOTE

The procedures and quantities listed are for disassembly of one cylinder head assembly. These procedures are the same for any one of the three cylinder head assemblies.

4-12. CYLINDER HEAD ASSEMBLY REPAIR (CONT)

2 Compress valve springs (1), remove two valve collets (2) and valve spring guide (3).

3 Release valve spring compressor and remove valve spring (1) valve spring guide (4).

4 Remove valve (5).

5 Remove valve seat (6), if required.

6 Remove injector sleeve (7) and injector O-ring (8).

7 Remove crossheads (9).

8 Remove crosshead guide (10).

9 Remove valve guide (11), if required.

10 Remove capscrew (12) securing cover plate (13) and O-ring (14) to cylinder head (15).

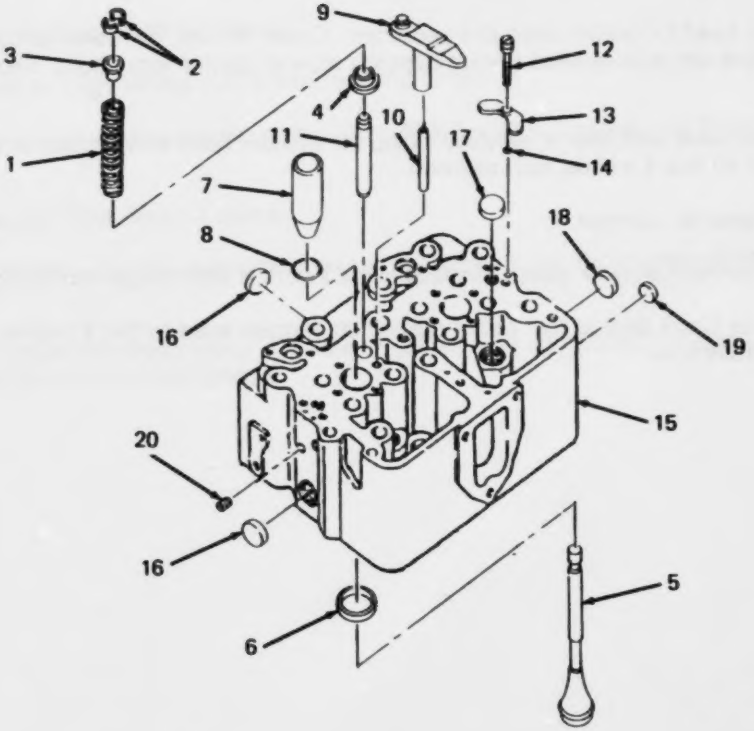
11 Remove two expansion plugs (16).

12 Remove expansion plug (17).

13 Remove six expansion plugs (18).

14 Remove three pipe plugs (19).

15 Remove expansion plug (20).



4-12. CYLINDER HEAD ASSEMBLY REPAIR (CONT)

CLEANING:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean cylinder head assembly with dry cleaning solvent. Wire brush where necessary. Dry with compressed air.

2 Clean fuel passages in cylinder head with cleaning brush and dry cleaning solvent. Dry with compressed air.

3 Clean oil passages in cylinder head with cleaning brush and dry cleaning solvent. Dry with compressed air.

4 Polish cylinder head surface with orbital sander.

INSPECTION:

1 Inspect cylinder head for cracks using dye penetrant. Check for rust, corrosion, and excessive heat damage. Remove any accumulated carbon deposits around injector spray hole. Replace cylinder head if it is damaged.

2 Inspect for loose valve seat inserts, carefully hitting the cylinder head with a wood or rubber mallet. If insert is loose enough so that it moves, replace insert.

3 Check valve guides for damage.

4 Inspect inside diameter of valve guide. Replace guide if bore is worn larger than 0.455 inch (11.56 mm).

5 Use bore gage to check bore at four points spaced 90 degrees apart to find if bore is out-of-round. Check the full length of the bore.

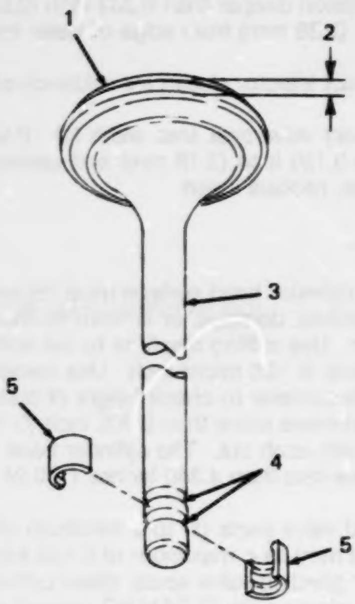
4-12. CYLINDER HEAD ASSEMBLY REPAIR (CONT)

6 Inspect valve head (1) for damage. Discard valve if rim measurement (2) is less than 0.105 inch (2.67 mm).

7 Inspect outside diameter of valve stem (3). Discard valve if outside diameter of valve stem measures less than 0.449 inch (11.44 mm).

8 Inspect grooves (4) in valve stem for wear. Valve collets (5) must fit tightly in grooves. Discard valve and matching collets if grooves are worn enough that collets are loose.

9 Inspect valve spring free length. Discard any spring having a free length shorter than 2.685 inches (68.20 mm).



10 Inspect valve spring working length as follows:

- a. Compress spring to 1.724 inches (43.79 mm) working length.
- b. Check that force required to compress spring to working length is between 162.75 and 147 lbs (724 and 655 N).
- c. Discard springs not within limits of step b.

11 Inspect crosshead guides. Outside diameter of crosshead guides must not be worn smaller than 0.432 inch (10.97 mm).

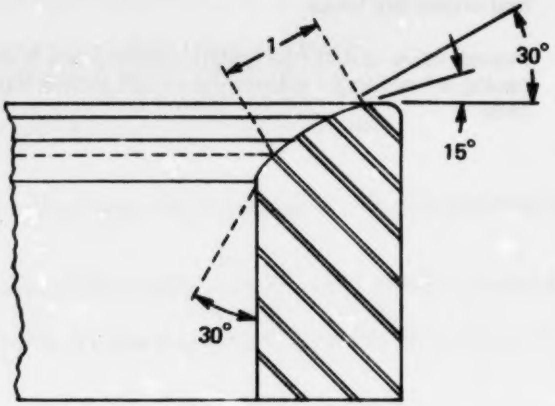
12 Inspect crosshead guides for straightness. Crosshead guides must be at a right angle to surface at cylinder head. Replace any guide that is not straight.

4-12. CYLINDER HEAD ASSEMBLY REPAIR (CONT)

13 Inspect surface of cylinder head around water holes. The holes must not have any scratches, cracks, or corrosion deeper than 0.003 inch (0.08 mm). There must not be any defect which extends more than 0.094 inch (2.38 mm) from edge of water hole.

14 Inspect injector sleeve for evidence of coolant leakage. Check sleeve for scratches or other damage.

15 Inspect valve seat area width (1). If width is more than 0.125 inch (3.18 mm) and cannot be cut narrower, replace insert.



REPAIR:

1 The cylinder head surface must be repaired if it has scratches, damage, or is worn so that surface is not even. Use milling machine to cut surface. Keep surface at 125 micro-inch. Use vernier depth gauge or micrometer to check height of cylinder head. Do not remove more than 0.005 inch (0.13 mm) material with each cut. The cylinder head height must not be less than 4.340 inches (110.24 mm).

2 Grind valve seats (1) to a minimum of 0.063 inch (1.59 mm) to a maximum of 0.125 inch (3.18 mm). After grinding valve seats, clean cylinder head in accordance with CLEANING procedure this task. Use a 1/2 inch (13.7 mm) bristle brush to clean the valve guide inside diameter.

3 Repair damaged valve guide bores by reaming bore to measure 0.760 to 0.761 inch (19.30 to 19.33 mm) inside bore. Remove sharp edges and install oversize valve guide in cylinder head.

4 Repair valves by grinding valve face to an angle exactly 30 degrees from the horizontal position of the valve.

5 Lap valves using valve lapping compound.

6 Using prussian blue, make sure valve face has correct contact against valve seat.

4-12. CYLINDER HEAD ASSEMBLY REPAIR (CONT)

ASSEMBLY:

1 Install expansion plugs (1).

2 Apply antiseizing tape to threads and install three pipe plugs (2).

3 Install six expansion plugs (3).

4 Install expansion plug (4).

5 Install two expansion plugs (5).

6 Position O-ring (6) and cover plate (7) on cylinder head (8) and secure using capscrew (90).

7 Install valve guides (10) if required.

8 Install crosshead guides (11).

9 Install crossheads (12).

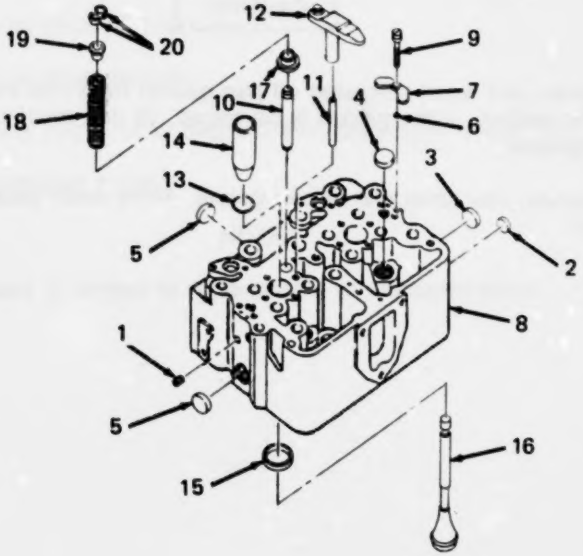
10 Install injector O-ring (13) and injector sleeve (14).

11 Install valve seats (15) if required.

12 Install valves (16).

13 Install spring guide (17) and valve spring (18).

14 Install valve spring guide (19) and using valve spring compressor, compress valve spring and install valve collets (20).



4-13. FLYWHEEL AND FLYWHEEL HOUSING REPAIR (REAR OIL SEAL)

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Crankshaft oil seal driver (Item 39, Appendix B)

Torque wrench (Item 2, Appendix B)

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix C)

Gasket

Soft cloth

Seal, rear oil

Equipment Condition Reference	Condition Description
Paragraph 3-37	Flywheel and flywheel housing removed

REMOVAL:

1 Loosen oil pan mounting capscrews four to five turns.

2 Remove four oil pan mounting capscrews that secure oil pan to rear cover.

CAUTION

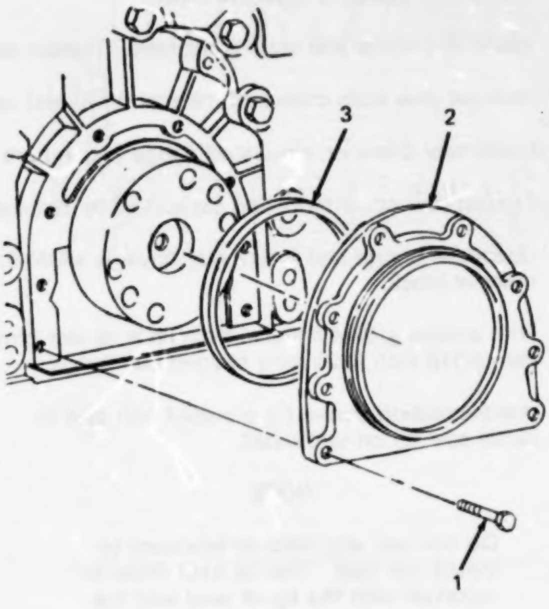
Use extreme care when releasing oil pan gasket from rear cover to prevent damage to gasket. If the gasket is damaged, oil pan must be removed and gasket replaced.

3 Insert feeler gauge between rear cover and oil pan gasket. Move feeler gauge back and forth to release gasket from rear cover.

4-13. FLYWHEEL AND FLYWHEEL HOUSING REPAIR (REAR OIL SEAL) (CONT)

4 Remove eight capscrews (1) from rear cover (2) and remove cover from crankshaft flange.

5 Remove oil seal (3) from rear cover.



CLEANING/INSPECTION/REPAIR:

1 Clean gasket surface of cylinder block and rear cover.

2 Inspect rear cover for cracks or other damage.

3 Use crocus cloth to remove any rust or other deposits from crankshaft flange.

4 Use a clean cloth to clean crankshaft flange.

NOTE

Repair is limited to replacement of damaged parts.

4-13. FLYWHEEL AND FLYWHEEL HOUSING REPAIR (REAR OIL SEAL) (CONT)

INSTALLATION:

1 Install new gasket on cylinder block.

2 Install rear cover and eight capscrews. Tighten capscrews just enough to hold rear cover in position.

3 Remove pins from crankshaft oil seal driver and use driver to align rear cover with crankshaft.

4 Install seal driver on crankshaft flange and in bore of rear cover.

5 Tighten rear cover mounting capscrews to 35 ft-lbs (45 N·m) torque, and remove crankshaft oil seal driver.

6 Use feeler gauge and insure rear cover is within 0.004 inch (0.10 mm) of being parallel with oil pan flange of cylinder block.

7 Trim excess gasket material from ends of rear cover gasket so that gasket is even or does not extend more than 0.010 inch (0.25 mm) beyond pan flange.

8 Use installation sleeve (1) provided with seal to install seal (2) on crankshaft.

NOTE

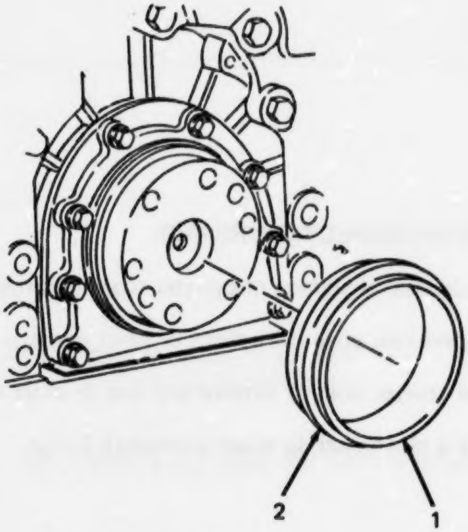
Do not use any kind of lubricant to install the seal. The oil seal must be installed with the lip of seal and the crankshaft clean and dry.

9 Push oil seal (2) over installation sleeve (1) onto crankshaft, and remove sleeve (1).

10 Install pins in crankshaft oil seal driver.

11 Use crankshaft oil seal driver to install oil seal in rear cover.

12 Install four capscrews which hold oil pan to rear cover.



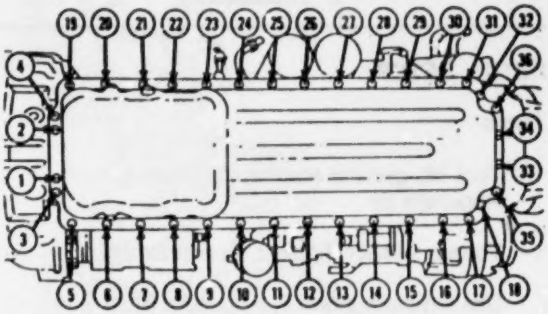
4-13. FLYWHEEL AND FLYWHEEL HOUSING REPAIR (REAR OIL SEAL) (CONT)

13 Tighten one of the 7/16-inch oil pan mounting capscrews on each side of oil pan, halfway between front and rear of oil pan, to 15 ft-lbs (20 N·m) torque.

14 Tighten four 5/16-inch capscrews in rear of oil pan to 20 ft-lbs (25 N·m) torque in sequence shown.

15 Tighten thirty-two (32) 7/16-inch capscrews to 50 ft-lbs (70 N·m) torque in sequence shown.

16 Install and align flywheel and flywheel housing in accordance with paragraph 3-37.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4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE

This task covers: a. Removal b. Disassembly c. Testing d. Cleaning/Inspection/Repair e. Assembly f. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Dial indicator (Item 5, Appendix B)

Suitable lifting device

Sling

Micrometer

Inside micrometer (Item 4, Appendix B)

Outside micrometer (Item 36, Appendix B)

Arbor press

Materials/Parts

Vegetable oil (Item 33, Appendix C)

Grease (Item 16, Appendix C)

Lubricating oil (Item 22, Appendix C)

Guide studs

Materials/Parts

Seals

Gear cover gasket

Manual References

TM 5-4320-307-10

Equipment Condition Reference	Condition Description
Paragraph 2-41	Drive belts removed
Paragraph 2-48	Fan removed
Paragraph 3-30	Accessory drive pulley removed

General Safety Instructions

Well ventilated area for steam cleaning and engine test run

REMOVAL:

1 Remove vibration damper (1) and pulley (2) as follows:

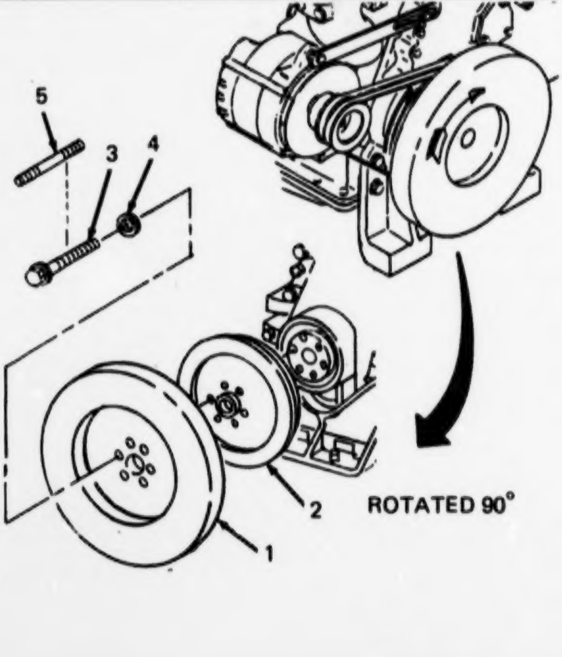
a. Remove one capscrew (3) and washer (4) holding vibration damper (1) and pulley (2) to crankshaft, and install guide stud (5) in its place.

CAUTION

Do not use a hammer or screwdriver to remove a viscous damper. These tools can cause damage to the damper.

b. Remove five remaining capscrews (3) with washers (4), and slide vibration damper (1) and pulley (2) off guide stud (5).

c. Remove guide stud (5).



4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

2 Loosen three capscrews and washers (6), and remove camshaft support (7), shims (8), and O-ring seal (9).

NOTE

Do not discard the shims.

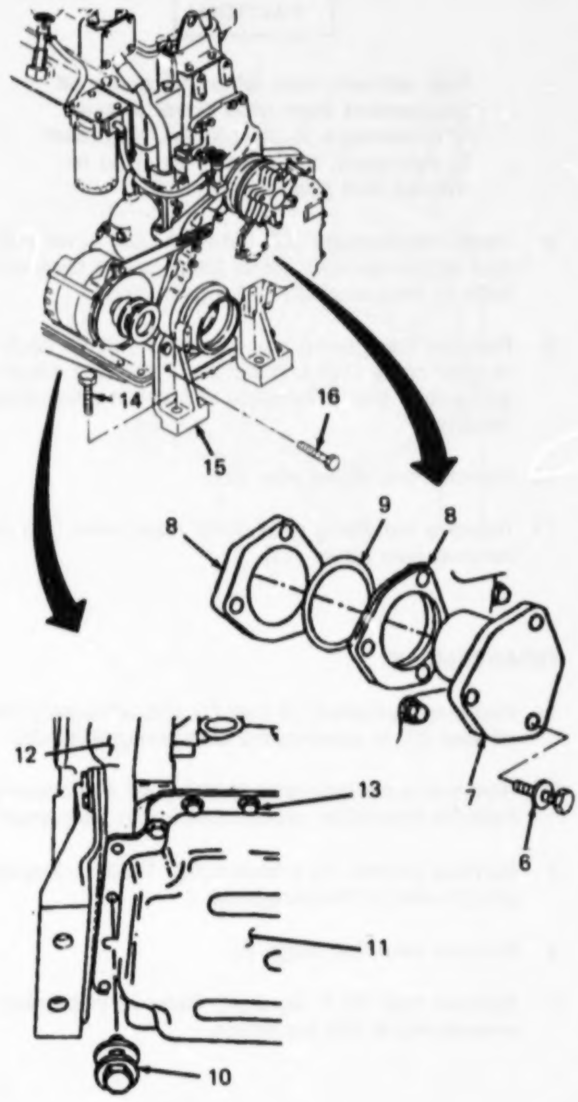
3 Remove four capscrews and washers (10) securing oil pan (11) to gear cover (12).

4 Loosen all remaining oil pan mounting capscrews (13) four to five turns.

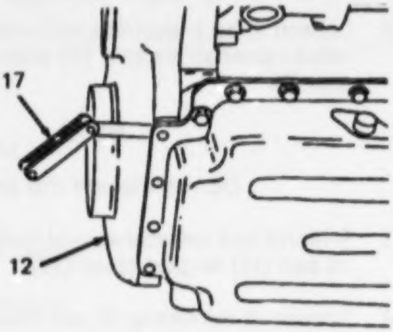
5 Remove two capscrews (14) securing front engine support (15) to skid.

6 Use an overhead hoist or hydraulic arm to support engine weight so that front engine support may be removed. Refer to paragraph 3-20.

7 Remove eight capscrews (16) securing front engine support (15) to gear cover (12) and remove front engine support.



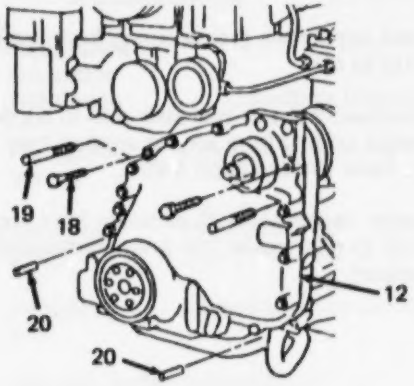
4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)



CAUTION

Use extreme care when releasing oil pan gasket from gear cover to prevent damage to the gasket. If gasket is damaged, the oil pan must be removed and gasket replaced.

8 Insert feeler gauge (17) between gear cover (12) and oil pan gasket. Move feeler gauge back and forth to release gasket from gear cover.



9 Remove one gear cover capscrew (18) on each side of gear cover (12) and install a 7/16-20 x 4-inch guide stud (19) in its place to support gear cover by removal.

10 Remove two dowel pins (20).

11. Remove remaining gear cover capscrews (18) and remove gear cover (12).

DISASSEMBLY:

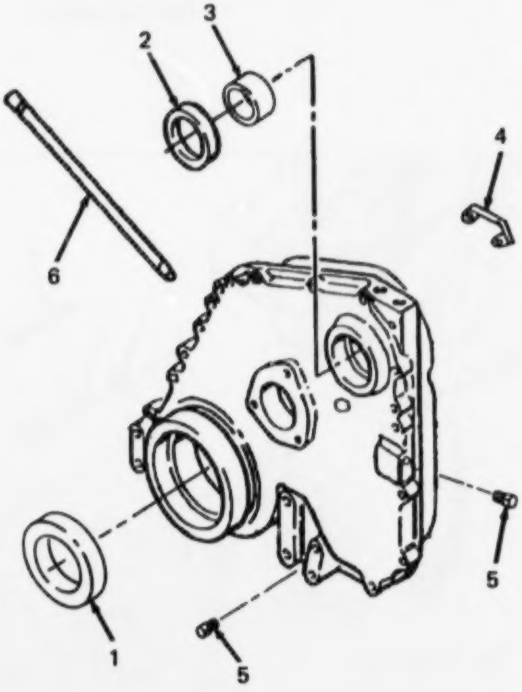
1 Remove crankshaft oil seal (1) and accessory drive oil seal (2), in accordance with paragraph 3-30.

2 Remove accessory drive bushing (3) if necessary. Refer to inspection procedures in this paragraph.

3 Remove pointer (4) if necessary. Refer to inspection procedures in this paragraph.

4 Remove two pipe plugs (5).

5 Remove tube (6) if required. Refer to inspection procedures in this paragraph.



4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

TESTING:

1 Test accessory drive gear (1) backlash as follows:

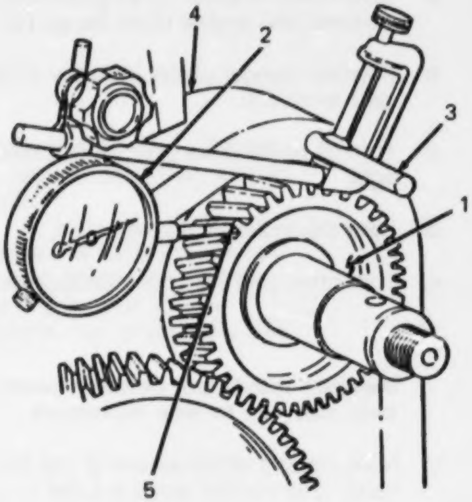
a. Mount dial indicator (2) to guide stud (3) screwed into engine block flange (4).

b. Position plunger of dial indicator (2) flat against gear tooth (5).

c. Turn accessory drive gear (1) clockwise until tight.

d. Zero dial indicator (2) index line.

e. Turn accessory drive gear (1) counterclockwise until tight.



NOTE

Measure movement between gears only, not side to side movement.

f. Note amount of movement of dial indicator hand. The normal range is 0.004 to 0.016 inch (0.10 to 0.40 mm). If less than 0.002 inch (0.05 mm), replace drive gear (1).

4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

2 Test oil pump drive gear (6) backlash as follows:

a. Mount dial indicator (2) to guide stud (3) screwed into engine block flange (4).

b. Position plunger of dial indicator (2) flat against gear tooth (7).

c. Turn oil pump drive gear (6) clockwise until tight.

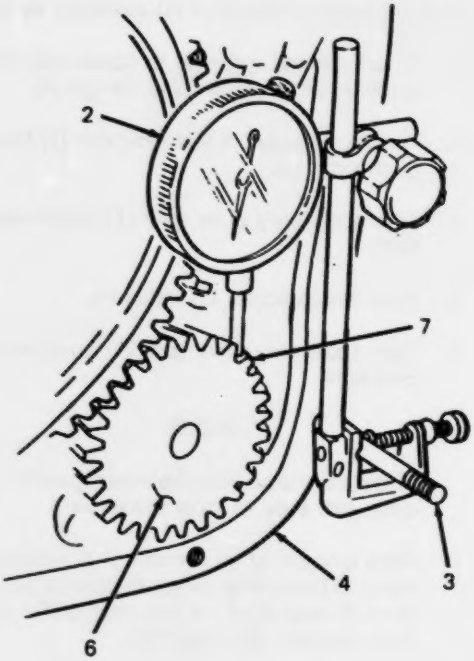
d. Zero dial indicator (2) index line.

e. Turn drive gear (6) counterclockwise until tight.

NOTE

Measure movement between gears only, not side to side movement.

f. Note amount of movement of dial indicator hand. The normal range is 0.004 to 0.016 inch (0.10 to 0.40 mm). If less than 0.002 inch (0.05 mm), replace drive gear (6).



4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

CLEANING/INSPECTION/REPAIR:

1 Scrape gasket surface of gear cover (1) and mating surface on cylinder block.

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 $kgcm^2$) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

2 Clean gear cover (1) with steam and dry with compressed air.

3 Inspect gear cover (1) for cracks or damage. Replace if cracked, distorted, or bent.

4 Inspect accessory drive bushing (2) for wear or grooving. Measure bushing inside diameter. If inside diameter is greater than 1.7585 inches (44.666 mm) bushing must be replaced.

5 Inspect dowels (3) for bending or distortion. Replace as required.

6 Inspect all capscrews for thread damage. Replace as required.

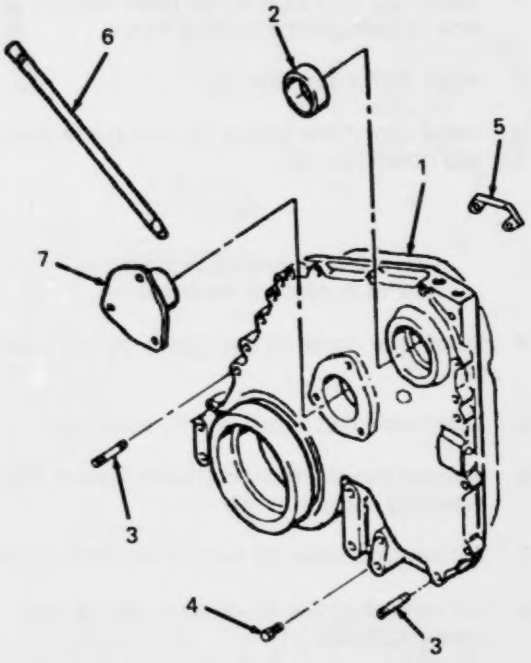
7 Inspect two pipe plugs (4) for thread damage. Replace as required.

8 Inspect pointer (5) for damage. Replace as required.

9 Inspect tube (6) for damage. Replace as required.

10 Inspect camshaft support (7) for cracks or damage. Measure inside diameter of support. Discard if inside diameter exceeds 1.757 inches (44.63 mm).

11 Inspect gear cover (1), gasket surface, and corresponding surface on cylinder block for nicks or burrs. Remove nicks and burrs.

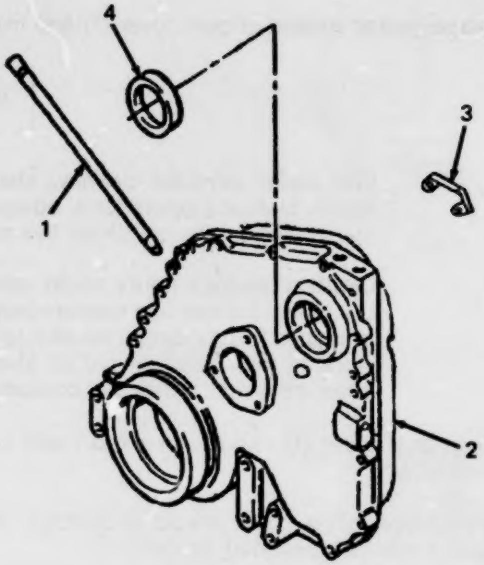


4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

ASSEMBLY:

1 Install tube (1) to gear cover (2).

2 Install pointer (3) to gear cover (2).



CAUTION

Make sure bushing and gear cover oil holes are in alignment. A 0.156-inch (3.96 mm) diameter rod must pass freely through oil holes.

3 Press accessory drive seal (4) into gear cover (2) using arbor press and accessory drive bushing mandrel.

INSTALLATION:

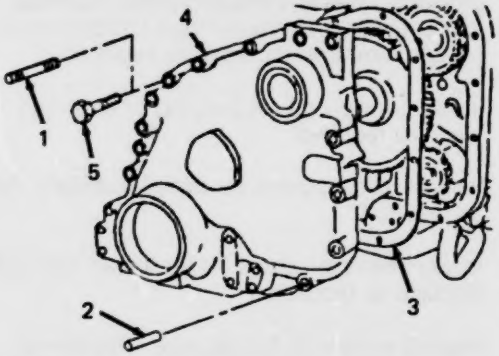
1 Install one 7/16-20 x 4-inch guide stud (1) in each side of gear cover mounting flange.

2 Install two dowel pins (2).

3 Install gear cover gasket (3) over guide studs (1) and dowel pins (2).

NOTE

Use a film of grease to hold the gasket in place if necessary.



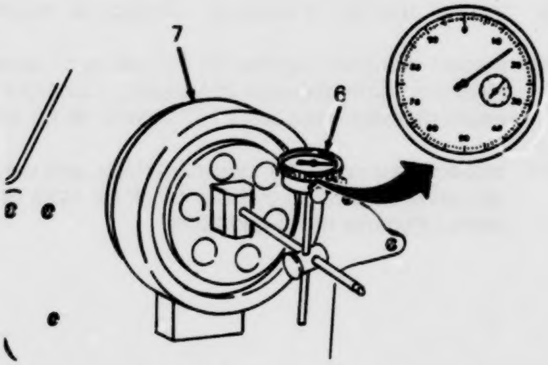
4 Install gear cover (4) over guide studs (1) and dowel pins (2).

5 Install mounting capscrews (5) hand tight.

6 Remove two guide studs (1) and replace with mounting capscrews (5).

7 Tighten capscrews (5) to 50 ft-lbs (70 N•m) torque.

8 Cut ends of gasket (3) off even with oil pan mounting flange.



9 Mount dial indicator (6) on front face of crankshaft (7). Put indicator plunger against oil seal bore, and set dial indicator to 0 (zero).

10 Rotate crankshaft one complete revolution while monitoring indicator. Total indicator reading must not exceed 0.010 inch (0.025 mm).

4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

11 If total indicator reading exceeds 0.010 inch (0.25 mm), remove gear cover and check cover and housing for nicks or burrs.

12 Remove nicks or burrs and clean cover and housing surfaces thoroughly.

13 Repeat gear cover installation and check again with dial indicator.

14 Install front engine support (8) to engine with capscrews (9). Tighten capscrews to 50 ft-lbs (70 N-m) torque.

15 Release tension on hoist and install capscrews (10) that secure front engine support (8) to skid.

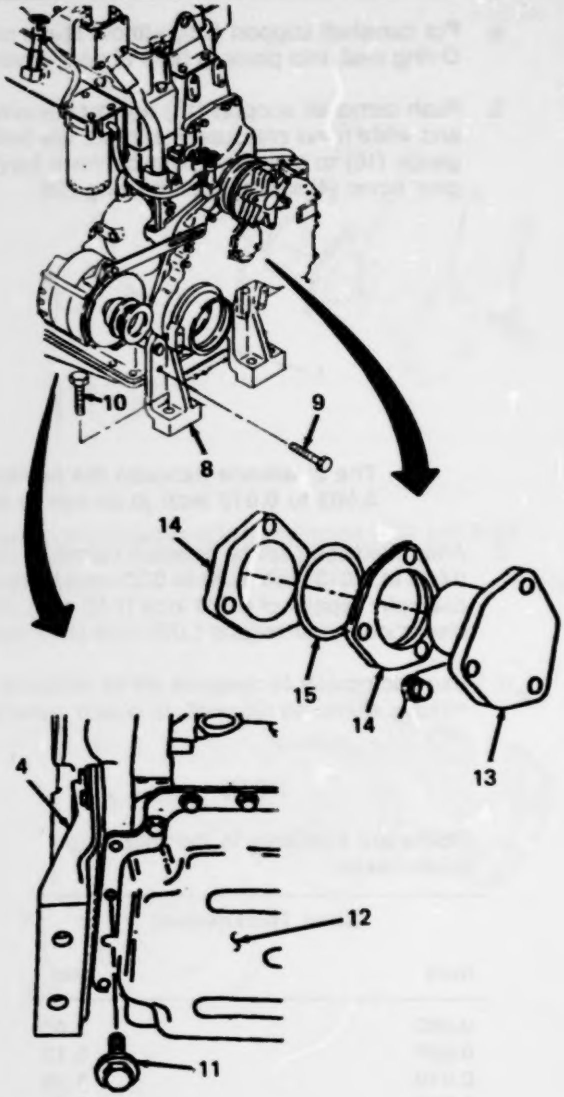
16 Install four capscrews and washers (11) that secure oil pan (12) to gear cover (4), hand tight.

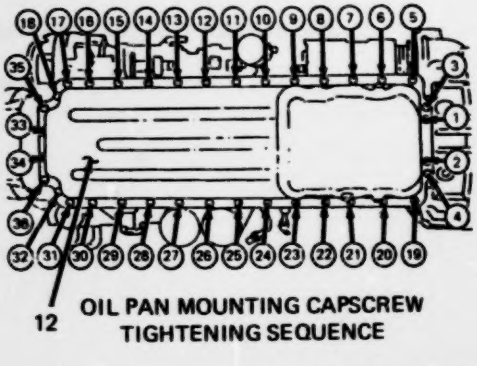
17 Tighten one of the oil pan mounting capscrews (11) on each side of oil pan (12), halfway between front and rear of oil pan, to 15 ft-lbs (20 N-m) torque.

18 Tighten four oil pan mounting capscrews (11) at rear of oil pan (12) to 20 ft-lbs (25 N-m) torque in sequence shown.

19 Tighten remaining oil pan mounting capscrews (11) to 50 ft-lbs (70 N-m) torque in sequence shown.

20 Install camshaft support (13) with shims (14) and O-ring (15) as follows.



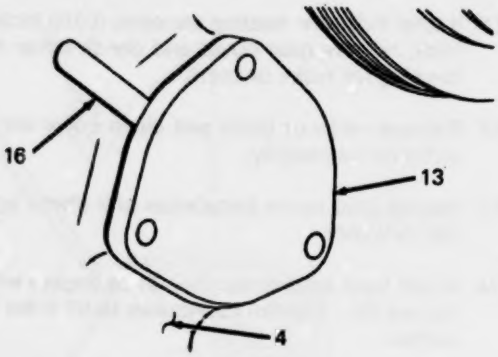


OIL PAN MOUNTING CAPSCREW TIGHTENING SEQUENCE

4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

a. Put camshaft support (13), without shims or O-ring seal, into place in bore of gear cover (4).

b. Push camshaft support (13) against camshaft and while hand pressure is applied, use feeler gauge (16) to measure space between flange of gear cover (4) and support bearing (13).



NOTE

The clearance between the bearing support and the camshaft gear must be 0.008 to 0.013 inch (0.20 mm to 0.33 mm).

c. After measuring space between camshaft support (13) and flange of gear cover (4), add an additional 0.008 to 0.013 inch (0.20 to 0.33 mm) to that number to determine thickness of shims required. Example: space of 0.060 inch (1.52 mm), measured with feeler gauge, plus 0.010 inch (0.25 mm) for clearance would require 0.070 inch (1.77 mm) shims.

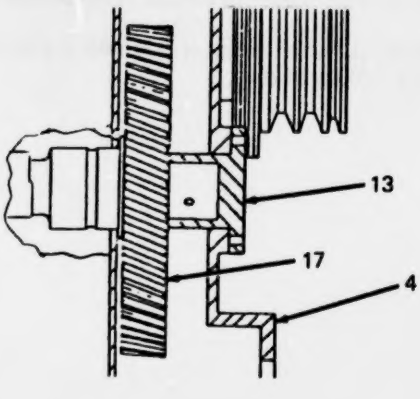
d. Use micrometer to measure shims removed from camshaft support (13) at time of disassembly. Add or remove shims, as required, to obtain correct clearance between camshaft support and camshaft gear (17).

NOTE

Shims are available in the following thicknesses:

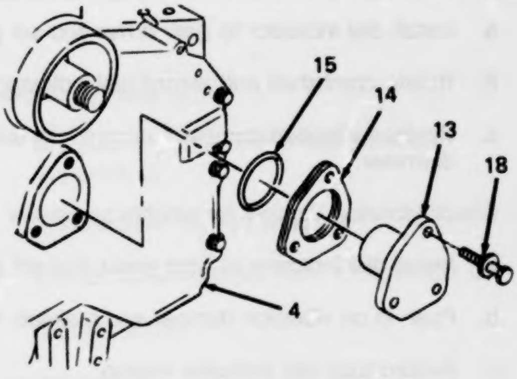
Shim Thicknesses

Inch	mm
0.002	0.05
0.005	0.13
0.010	0.25
0.025	0.63



4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

e. Install required number of shims (14) and new O-ring (15) on camshaft support (13).



CAUTION

Do not use lubricating oil on the O-ring. The O-ring will increase in size on contact with lubricating oil. Use vegetable oil to lubricate O-ring.

f. Lubricate O-ring (15) with vegetable oil.

g. Install camshaft support (13) into gear cover (4). Install and tighten capscrews and washers (18) to 20 ft-lbs (25 N•m) torque.

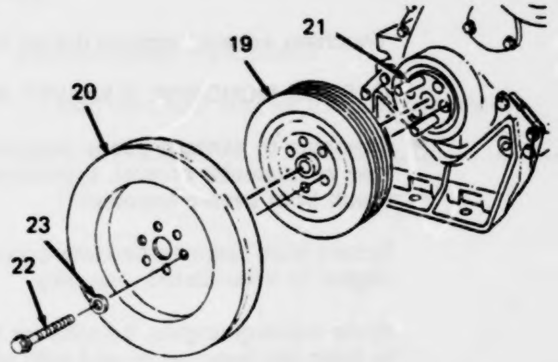
21 Install new crankshaft oil seal and accessory drive oil seal in accordance with paragraphs 3-38 and 3-29.

22 Install accessory drive pulley in accordance with paragraph 3-29.

23 Install crankshaft pulley (19) and vibration damper (20) as follows:

a. Install two guide studs (21) in crankshaft.

b. Install pulley (19) and vibration damper (20) on guide studs (21).



NOTE

Make sure mounting surfaces of crankshaft, vibration damper, and pulley are clean, dry, and free from burrs.

c. Lubricate threads of capscrews (22) and face of washers (23) with lubricating oil.

d. Install four capscrews (22) with washers (23) handtight.

e. Remove two guide studs (21) and replace with two capscrews (22) and washers (23).

f. Tighten six capscrews (22) to 190 ft-lbs (260 N•m) torque.

4-14. GEAR COVER ASSEMBLY REPAIR/REPLACE (CONT)

24 Check eccentricity of vibration damper as follows:

a. Install dial indicator to gear cover and set plunger on edge of vibration damper.

b. Rotate crankshaft and record dial indicator movement.

c. Replace vibration damper if eccentricity exceeds 0.004 inch (0.10 mm) per 1.0 inch (25.4 mm) of damper diameter.

25 Check vibration damper for wobble as follows:

a. Install dial indicator to gear cover and set plunger on front surface of vibration damper.

b. Push in on vibration damper and maintain hand pressure while rotating damper 360 degrees.

c. Record total dial indicator motion.

d. Replace damper if wobble exceeds 0.007 inch (0.18 mm) per 1.0 inch (25.4 mm) of radius.

26 Install all drive belts in accordance with paragraph 2-41.

WARNING

Touching exhaust system during test can cause severe burns.

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation. Operate engine in a ventilated area only.

While running engine, be alert for fumes. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

27 Start engine in accordance with TM 5-4320-307-10, and operate until it reaches a temperature of 180°F (80°C).

28 Check for leaks at gear cover oil seals and gaskets.

4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE

This task covers: a. Inspection b. Removal c. Cleaning/Inspection d. Disassembly e. Assembly f. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Dial indicator (Item 3, Appendix B)

Camshaft installation, pilots (Item 44, Appendix B)

Outside micrometer (Item 36, Appendix B)

Inside micrometer (Item 4, Appendix B)

Gear puller

V-blocks (Item 3, Appendix B)

Oven

Materials/Parts

Dry cleaning solvent P-D-680 (Item 30, Appendix C)

Grease (Item 16, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

Rubber bands

Equipment Condition Reference	Condition Description
Paragraph 4-14	Gear cover assembly removed
Paragraph 3-34	Cam followers removed

General Safety Instructions

Well ventilated area for cleaning operations

INSPECTION:

1 Check camshaft gear backlash as follows:

a. Attach dial indicator (1) to guide stud (2) screwed into engine block.

b. Rotate camshaft gear (3) as far clockwise as it will move by hand and hold in place.

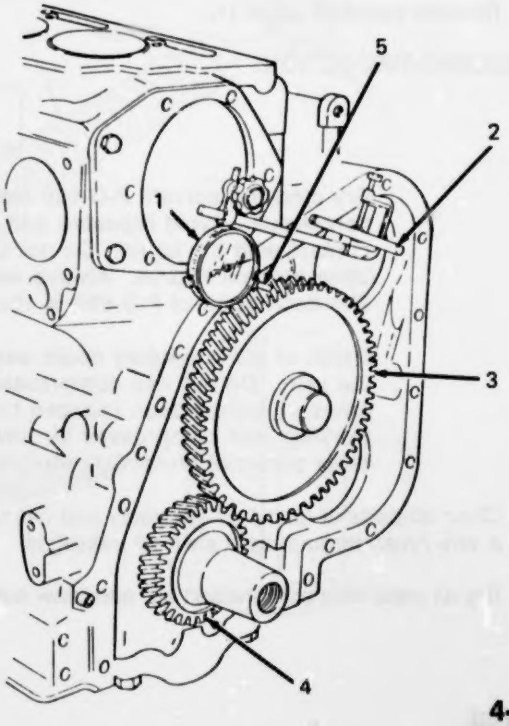
NOTE

Crankshaft gear (4) must not move.

c. Position indicator probe (5) to camshaft gear (3) tooth and set indicator (1) to zero.

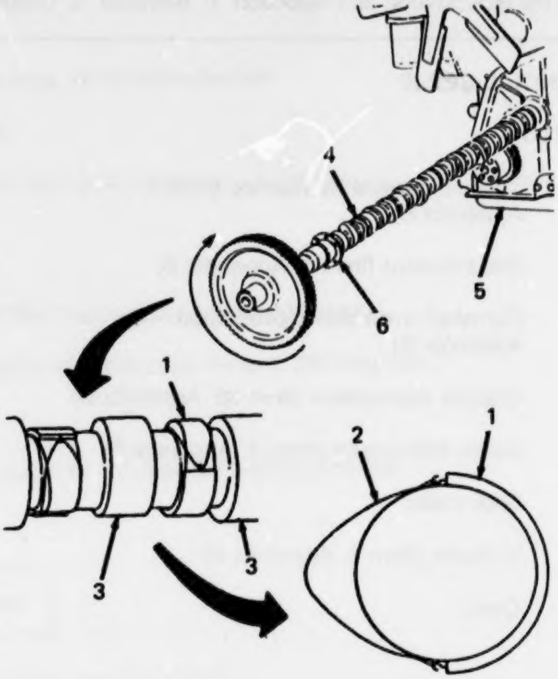
d. Rotate camshaft gear (3) counterclockwise and read dial indicator (1) when rotation stops.

e. If backlash is more than 0.020 inch (0.51 mm), camshaft gear (3) must be replaced.



4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

REMOVAL:



WARNING

Use care when removing camshaft to avoid damaging camshaft bushings.

1 Install four camshaft pilots (1) over outer base circle of valve lobes (2) between camshaft journals (3), using rubber bands to secure in place.

NOTE

The rubber band must straddle valve lobe.

2 Use one hand to slowly rotate and pull camshaft assembly (4) from cylinder block (5) and other hand to balance camshaft as it is removed.

CAUTION

Do not lay camshaft in a horizontal position. Avoid warping camshaft by securely supporting it in a vertical attitude.

3 Remove thrust washer (6) from camshaft assembly (4).

4 Remove camshaft pilots (1).

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all parts of camshaft assembly and camshaft bushings in engine block, with dry cleaning solvent. Run a wire brush through cam shaft oil passages.

2 Dry all parts with compressed air, and blow out camshaft oil passages.

4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

3 Inspect camshaft (1) as follows:

a. Check for cracks, breaks, or pits. Replace camshaft (1) if damage is present.

b. Inspect cams and bushing journals for wear and scoring. If cams are scored, inspect cam followers in accordance with paragraph 3-33. Replace camshaft (1) if excessive scoring is noted. Minor nicks or scratches on cams may be repaired with surfacing stone. Do not attempt to repair journals.

c. Measure outside diameter of camshaft bushing journals, using micrometer. If any of the seven journals does not measure between 2.495 inches (63.37 mm) and 2.497 inches (63.42 mm), replace camshaft (1).

4 Inspect camshaft gear (2) for cracks, broken or chipped teeth or pitting. Replace gear if damage is present or if pitting extends over more than 1/4 width of tooth.

NOTE

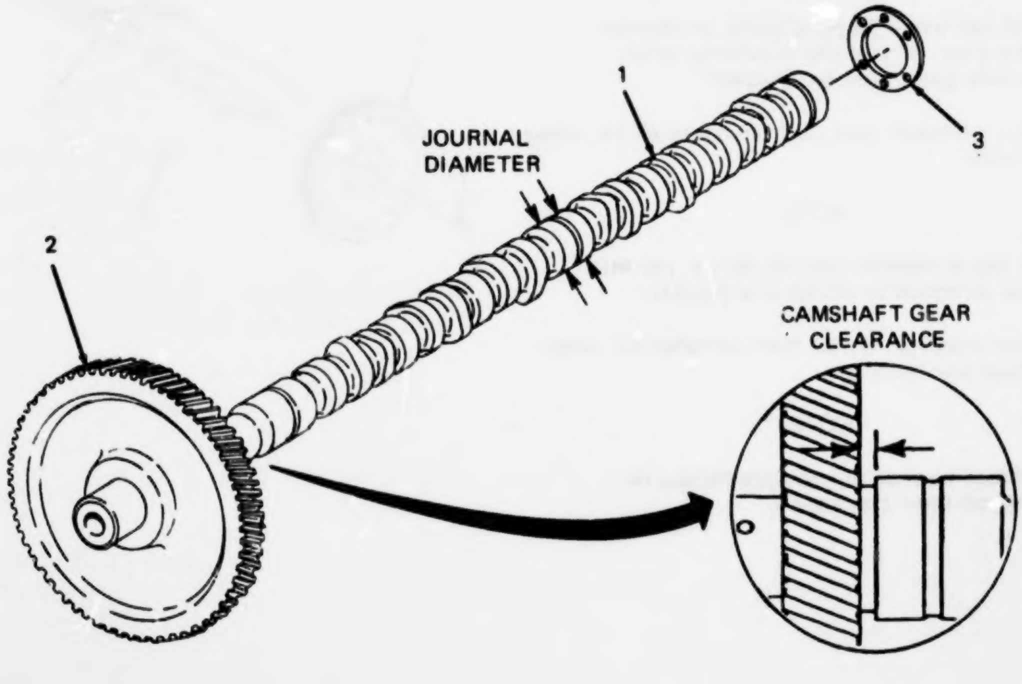
Minor nicks, burrs, or wear on gear may be smoothed out with crocus cloth.

5 Inspect thrust washer (3) as follows:

a. Check for cracks, breaks, or pits. Replace thrust washer (3) if damage is present.

b. Measure thickness of thrust washer (3) with micrometer. Discard if thickness is less than 0.090 inch (2.29 mm).

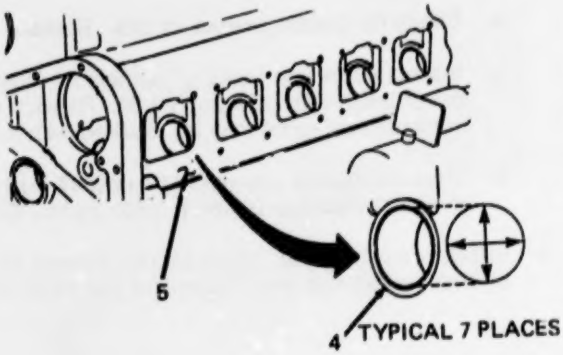
6 Use a feeler gage to measure clearance between camshaft gear (2) and shoulder on camshaft (1). The clearance must not exceed 0.005 inch (0.13 mm).



4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

7 Measure all camshaft bushings (4) in cylinder block (5) using inside micrometer.

8 If inside diameter of installed bushing (4) is not between 2.4983 and 2.5023 inches (63.457 and 63.558 mm), replace bushings. Refer to paragraph 4-18 for replacement procedure.



DISASSEMBLY:

1 Support camshaft assembly (1) on V-blocks.

2 Remove camshaft plug (2).

CAUTION

Do not use a heating torch to remove the gear. If you use a heating torch, a new gear must be installed.

3 Remove camshaft gear (3) from camshaft (4), using gear puller.

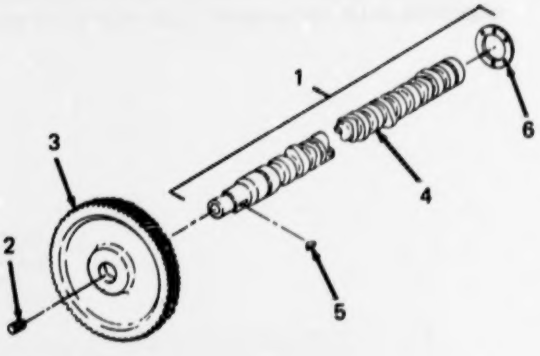
NOTE

If key is marked with an arrow, record the direction in which it is pointed.

4 Remove woodruff key (5) from camshaft (4) using flat chisel and hammer.

NOTE

Thrust washer (6) was previously removed from crankshaft.



4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

ASSEMBLY:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 If a new camshaft is to be installed, steam clean camshaft to remove rust preventive.

2 Blow out camshaft oil passages and dry camshaft with compressed air.

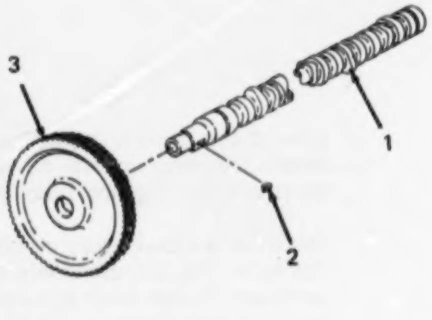
CAUTION

After camshaft has been steam cleaned, do not touch machined surfaces with bare hands. This will cause rust to form. Lubricate camshaft before handling.

4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

3 Lubricate new camshaft (1) with clean lubricating oil before handling.

4 Inspect woodruff key (2) for damage and replace if necessary.



NOTE

If new woodruff key is used, use the same part number key as the one that is replaced.

5 Use brass drift to install woodruff key (2) into keyway in camshaft (1), being sure that arrow on key points in same direction as when key was removed.

6 Install camshaft gear (3) on camshaft (1) as follows:

a. Check that keyway in crankshaft gear (3) is free of burrs or damage. Remove burrs with fine crocus cloth. If damage or excessive burring is present, gear must be replaced.

b. Measure gear (3) bore. The internal diameter must be between 1.7977 and 1.7985 inches (45.662 and 45.682 mm).

c. Check that gear mounting area on crankshaft (1) is free of burrs and fretting. Remove burring and fretting with fine crocus cloth.

CAUTION

If area of fretting is longer than a 0.125-inch (3.175 mm) wide longitudinal band, do not use crankshaft. Gear movement on crankshaft may result.

d. Replace camshaft (1) if excessive damage is present.

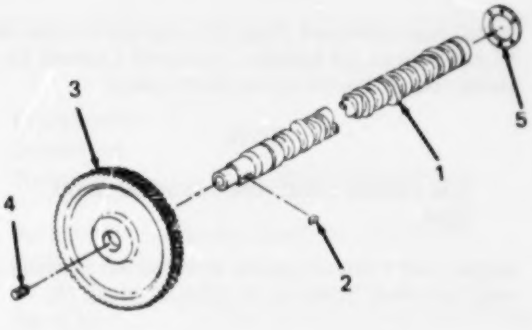
e. Measure camshaft in gear mounting area using micrometer. The outside diameter must be between 1.8005 and 1.8010 inches (45.733 and 45.745 mm).

4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

f. Put camshaft (1) in a vertical position with gear fit area (nose) pointing up.

g. Apply grease to camshaft (1) gear fit area.

h. Heat camshaft gear (3) in an oven at 500°F (260°C) for a minimum of one hour.



WARNING

Wear protective gloves when handling parts that have been heated, to prevent personal injury.

i. Remove gear (3) from oven.

NOTE

Camshaft gear must be installed within 30 seconds after removal from oven.

j. Stand camshaft (1) on a wood block, in vertical position with gear fit area up.

k. Align keyway in gear (3) with key (2) in camshaft (1), and with timing marks on gear facing away from camshaft, install gear on camshaft. Use a brass drift and hammer to drive gear against camshaft shoulder.

l. Use feeler gauge to measure clearance between camshaft gear (3) and shoulder on camshaft (1). Clearance must not exceed 0.005 inch (0.13 mm).

7 Check threads on camshaft plug (4) for damage. Use new plug if damaged.

8 Install camshaft plug (4) into nose end of camshaft (1).

9 Apply a thin film of grease to both sides of thrust washer (5).

CAUTION

The oil grooves on thrust washer must be toward camshaft gear to prevent thrust washer failure.

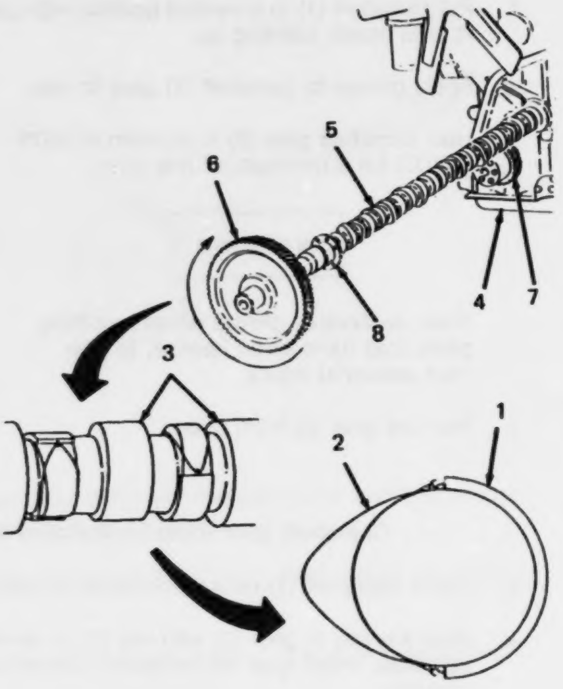
10 Install thrust washer (5) on camshaft (1).

NOTE

Keep camshaft in a vertical position with gear up, until gear has cooled.

4-15. CAMSHAFT ASSEMBLY INSPECT/REPAIR/REPLACE (CONT)

INSTALLATION:



1 Install four camshaft pilots (1) over outer base circle of valve lobes (2) between camshaft journals (3), using rubber bands to secure in place.

NOTE

The rubber band must straddle valve lobe.

2 Apply a thin film of grease to camshaft journals (3) and camshaft bushings in cylinder block (4).

3 Install camshaft (5) into cylinder block (4), rotating camshaft (5) slowly as it enters block.

4 Align the O mark on camshaft gear (6) with O mark on crankshaft gear (7), and push camshaft in until thrust washer (8) fits against cylinder block (4).

5 Remove camshaft installation pilots (1), being careful not to drop rubber bands into cylinder block (4).

NOTE

Backlash need be checked only if a new gear has been installed.

6 Check camshaft gear backlash in accordance with inspection procedure in this paragraph. Backlash must be between 0.002 and 0.020 inch (0.05 and 0.50 mm).

7 Install gear cover assembly in accordance with paragraph 4-14.

8 Install cam followers in accordance with paragraph 3-34.

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR

This task covers: a. Removal b. Cleaning/Inspection/Repair c. Assembly d. Installation

INITIAL SETUP

Tools

- Tool kit, general mechanics (Item 1, Appendix B)
- Torque Wrench (Item 2, Appendix B)
- Internal snap ring pliers (Item 2, Appendix B)
- T-handle piston pusher
- Piston ring expander (Item 45, Appendix B)
- Connecting rod guide pins (2)
- Ring groove wear gauge
- Piston pin snap rings
- Snap ring pliers (Item 2, Appendix B)
- Piston pin bushing inserter
- Piston ring compressor
- Outside micrometer (Item 36, Appendix B)
- Inside micrometer (Item 4, Appendix B)
- Rubber Hammer

Materials/Parts

- Dry cleaning solvent (Item 30, Appendix C)
- Crocus abrasive cloth (Item 1, Appendix C)
- Lubricating oil (Item 22, Appendix C)
- Grease (Item 16, Appendix C)
- Liquid soap (Item 20, Appendix C)
- Lint free cloth (Item 19, Appendix C)

Equipment Condition Reference	Condition Description
Paragraph 3-20	Engine assembly removed
Paragraph 3-38	Oil pan assembly removed from engine
Paragraph 3-36	Cylinder head assembly removed from engine
Paragraph 4-18	Piston cooling nozzles removed

General Safety Instructions

Well ventilated area for cleaning procedures

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

REMOVAL:

1 Use scraper with aluminum blade to remove ring of carbon deposits at top of cylinder liner.

2 Remove loose carbon from cylinders, using lint-free cloth.

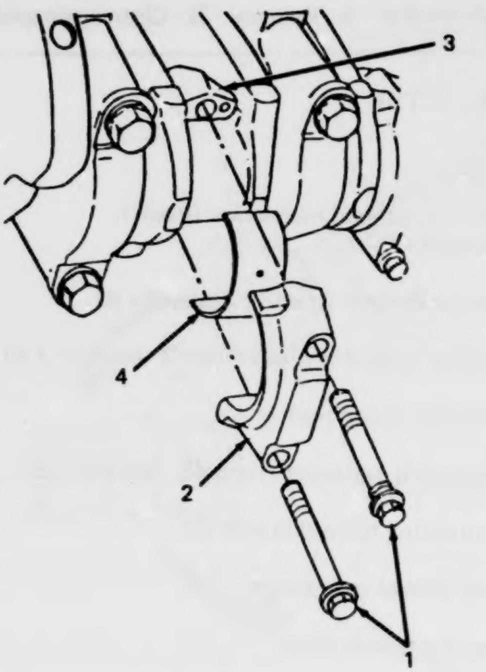
3 Loosen all connecting rod bolts (1) but do not remove.

4 Use a rubber hammer to hit connecting rod bolts to loosen cap (2) from dowel in connecting rod (3).

5 Check to see that cap (2) and connecting rod (3) have matching numbers and are in correct cylinder location. If no numbers are present they must be marked before removing. Make note of the side of engine on which numbers are stamped.

6 Remove bolts (1), caps (2), and lower connecting rod bearing shells (4).

7 Mark cylinder number and letter L in flat surface of bearing tang.



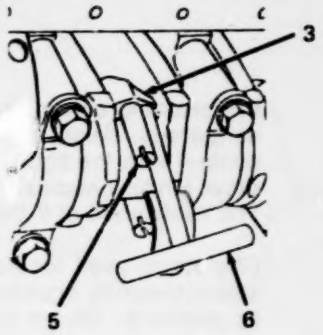
4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

8 Install two connecting rod guide pins (5) into each connecting rod (3).

9 Use a T-handle piston pusher (6) to push connecting rod (3) away from crankshaft, until all piston rings are clear of top of cylinder liner.

10 Remove all piston and connecting rod assemblies.

11 Check to see that piston tops are marked for cylinder location. If not, stamp cylinder number on piston top toward camshaft side of engine.



DISASSEMBLY:

1 Remove upper connecting rod bearing shell from connecting rod. Mark cylinder number and letter U in flat surface of bearing tang.

2 Use piston ring expander (1) to remove four rings (2) from each piston (3).

NOTE

The upper three rings are compression rings and lower ring is oil ring.

3 Place a tag on rings, recording cylinder number of piston for future reference.

4 Use internal snap ring pliers to remove snap ring (4) from either side of piston (3). Discard snap rings.

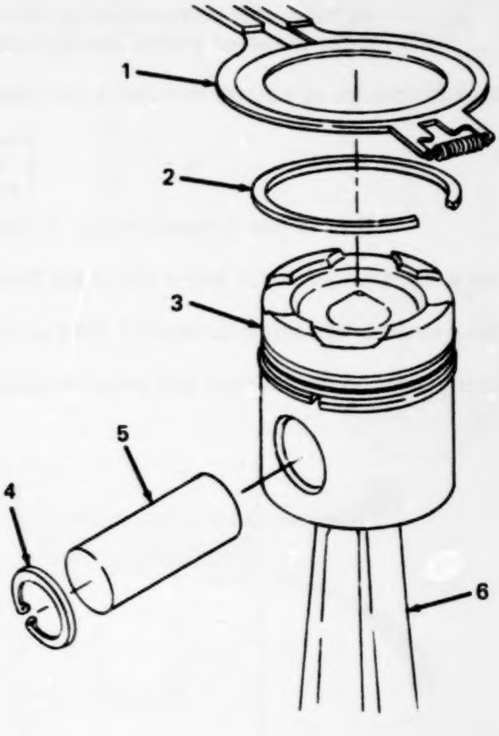
5 Heat piston in boiling water for 15 minutes.

WARNING

Use insulated gloves to prevent injury from boiling water or hot piston.

CAUTION

Do not use hammer to remove piston pin. This can distort piston.



6 Remove piston (3) from water and use blunt tool to remove piston pin (5) from piston and rod assembly.

7 Remove connecting rod (6) from piston (3).

8 Remove connecting rod guide pins (4).

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

CLEANING/INSPECTION:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Soak pistons for at least 30 minutes in dry cleaning solvent.

CAUTION

Do not use a metal brush. A metal brush will damage piston ring grooves.

2 Use a hot, soapy solution and a stiff bristle brush to remove carbon deposits.

3 Use a nylon bristle brush to clean oil drillings in connecting rods.

4 Steam clean connecting rod and piston assembly and dry with compressed air.

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

5 Visually inspect pistons (1) for cracks or damage in bowl (2), pin bore (3), or skirt (4). Check for scoring or evidence of overheating. Slight scoring may be removed with crocus cloth. Replace cracked, heavily scored, or damaged pistons.

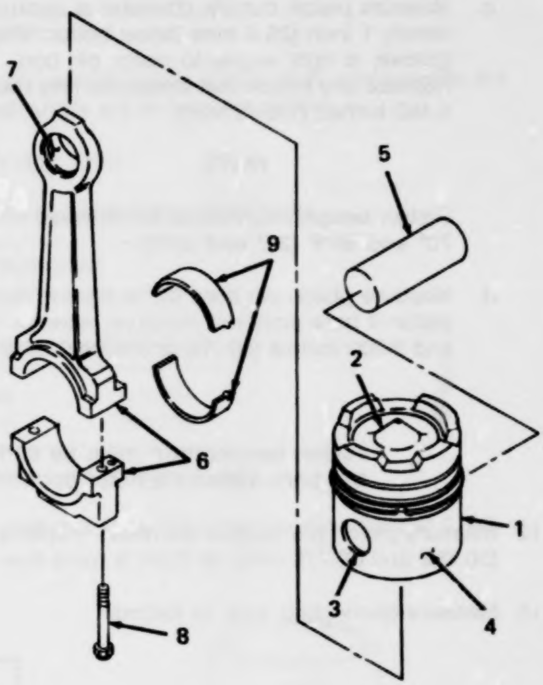
6 Visually inspect piston pins (5) for scratches, grooves, signs of overheating, or other damage.

7 Visually inspect connecting rod assemblies (6) for damage. Use magnetic method (Magnaglo) to locate cracks in connecting rods and caps. Replace rod if cracked or if I beam section is nicked or chipped, deeper than 1/32 inch (0.80 mm).

8 Visually inspect piston pin bushing (7) for damage or for misalignment of oil passage and bushing oil hole.

9 Visually inspect connecting rod bolts (8) for thread damage. Replace bolts with damaged threads. Use magnetic method (Magnaglo) to locate cracks in bolts. Replace cracked bolts.

10 Visually inspect connecting rod bearing shells (9) for grooving or other damage. Replace if damaged.



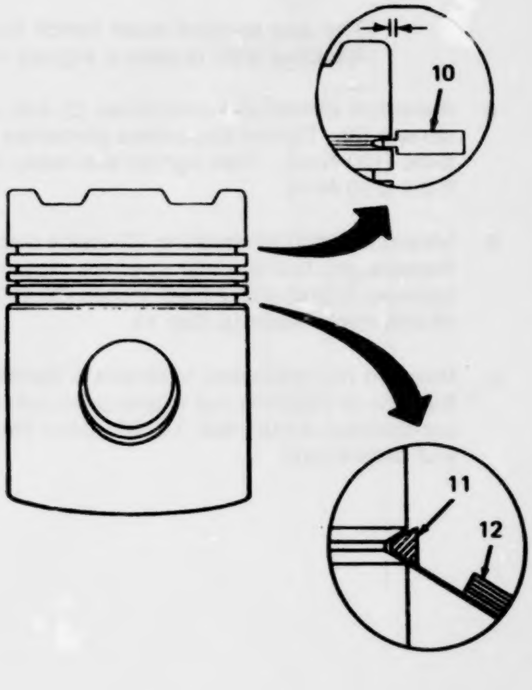
11 Measure pistons as follows:

a. Use a ring groove wear gauge (10) to check for depth wear in top and second ring grooves.

NOTE

The widest part of the tool (shoulder) must not come in contact with the piston. Replace piston if shoulder touches piston when tool is inserted in ring groove.

b. Use a new piston ring (11) and feeler gauge (12) to check each of the four ring grooves. Hold a new ring in groove and try to slide a 0.006 inch (0.152 mm) feeler gauge between ring and groove. If feeler gauge enters without resistance, there is too much wear and piston must be replaced.



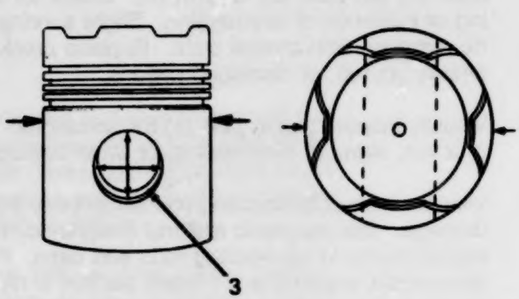
4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

c. Measure piston outside diameter at approximately 1 inch (25.4 mm) below bottom ring groove, at right angles to piston pin bore. Replace any piston that measures less than 5.483 inches (139.27 mm).

NOTE

Piston temperature must be between 70° and 90°F (21° and 32°C).

d. Measure piston pin bore (3) as shown. Replace piston if bore does not measure between 1.9985 and 2.000 inches (50.762 and 50.800 mm).



NOTE

Piston temperature must be 68°F (20°C). Add 0.0005 inch (0.013 mm) to the bore inside diameter per 10°F (5°C) temperature rise up to 90°F (32°C).

12 Measure piston pin outside diameter. Replace pin if diameter is not between 1.9985 and 1.9990 inches (50.762 and 50.775 mm), or if pin is more than 0.001 inch (0.03 mm) out of round.

13 Measure connecting rods as follows:

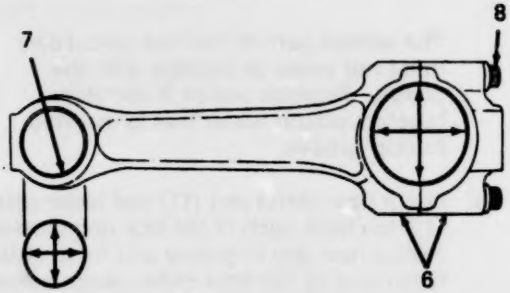
CAUTION

The cap number must match the number on the connecting rod and installed with numbers aligned to prevent damage to rods and caps.

a. Assemble connecting assemblies (6) with capscrews (8). Tighten capscrews alternately to 75 ft-lbs (100 N·m). Then tighten alternately to 170 ft-lbs (230 N·m).

b. Measure piston pin bushing (7) inside diameter. Replace any bushing that does not measure between 2.0010 and 2.0022 inches (50.825 and 50.856 mm). Refer to step 19.

c. Measure rod crankshaft bore inside diameter. Replace or machine rod if bore does not measure between 3.3157 and 3.3167 inches (84.219 and 84.244 mm).



4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

14 Measure connecting rod journal bearing clearances as follows:

a. Install connecting rod bearing shells into connecting rod assembly being sure that all components are marked with same cylinder number and lower and upper shells are in proper position.

b. Assemble connecting rod assembly in accordance with step 13(a).

c. Measure bearing inside diameter. Replace bearing shells if out of dimensional limits.

Bearing Clearance - Inch (mm)

Bearing Journal	New Dimension		
	Minimum	Maximum	Worn Limit
Connecting Rod	0.0015 (0.038)	0.0045 (0.114)	0.0070 (0.178)

15 Measure connecting rod journals on crankshaft in accordance with paragraph 4-17.

16 Measure piston rod bearing shell thickness. Replace any shell that is worn to a thickness of under 0.093 inch (2.362 mm).

17 Check piston ring gap as follows:

a. Compress piston ring (11) so that it can be inserted into cylinder liner (12) in which it will be used.

b. Use top part of piston (1) to push piston ring (11) into cylinder liner (13).

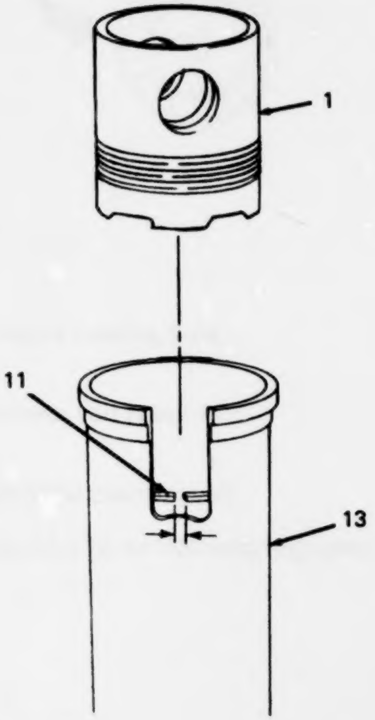
c. Use a feeler gauge to measure ring gap. Replace ring if it does not meet following specification:

Piston Ring Gap

Position	MIN	MAX
Top	0.017 inch (0.43 mm)	0.027 inch (0.68 mm)
Second	0.020 inch (0.51 mm)	0.030 inch (0.76 mm)
Third	0.019 inch (0.48 mm)	0.029 inch (0.74 mm)
Oil	0.010 inch (0.25 mm)	0.025 inch (0.64 mm)

NOTE

Add 0.003 inch (0.08 mm) to the maximum limit for each 0.001-inch (0.03 mm) wear in cylinder liner wall.



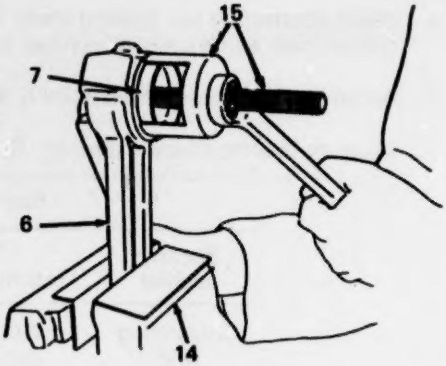
4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

18 Clean and inspect cylinder liners in accordance with paragraph 4-18.

19 If worn or damaged, remove piston pin bushings (7) as follows:

a. Clamp connecting rod (6) in a padded vise (14) with piston pin bushing inserter (15).

b. Tighten in on bushing inserter (15) nut to push out bushing (7).



20 Install new piston pin bushings as follows:

a. Loosen bushing inserter (15) nut and position new piston pin bushing (7) for assembly, being sure that oil holes in bushing and connecting rod bore are lined up.

b. Tighten in on bushing inserter (15) nut to pull bushing (7) into connecting rod (6).

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

ASSEMBLY:

1 Install piston pins as follows:

a. Install a new snap ring (1) in one snap ring groove of piston pin bore (2) in each piston (3).

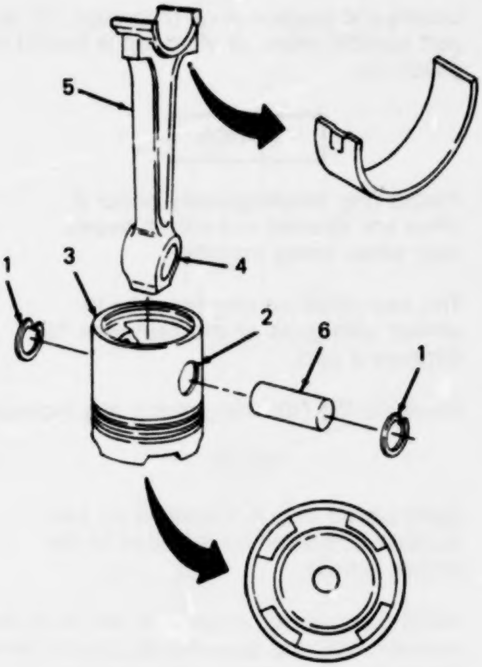
b. Heat pistons (3) in boiling water for 15 minutes or in an oven for 30 minutes at 212°F (100°C).

c. Lubricate piston pin bushing (4) in connecting rod (5) and piston pin (6) with lubricating oil.

WARNING

Wear insulated gloves to prevent injury from boiling water or heated pistons.

d. Use tongs to remove heated pistons (3).



CAUTION

The cylinder number stamped on piston top must be toward bearing tang side of connecting rod.

Do not use a hammer to install piston pins. Use of hammer can result in damage to piston.

e. Align pin bore (2) of piston (3) with connecting rod bushing (4) and install piston pin (6).

f. Install new snap ring (1) in remaining snap ring groove of piston pin bore (2) so that snap ring seats completely in groove.

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

2 Install piston rings as follows:

a. Locate and position rings (7 through 10) so that part number, mark, or word top is toward top of piston (3).

CAUTION

Piston ring breakage may occur if rings are opened more than necessary when being installed.

The two-piece oil ring must be installed with gaps of two elements 180 degrees a part.

b. Install oil ring (10) using piston ring expander.

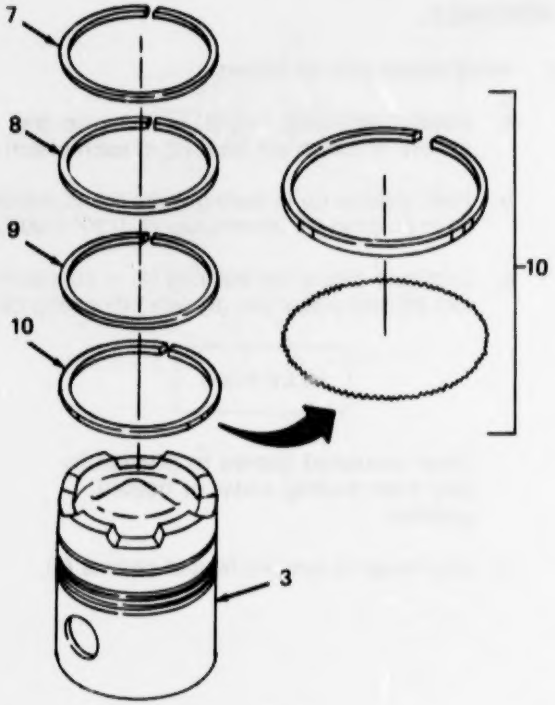
NOTE

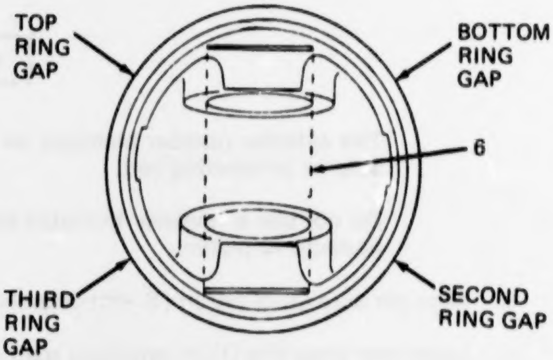
Each piston ring is identified by part number and must be installed in the proper groove.

c. Install compression rings (7, 8, and 9) in proper grooves, with ring gaps equally spaced around piston (3), 90 degrees apart as shown.

NOTE

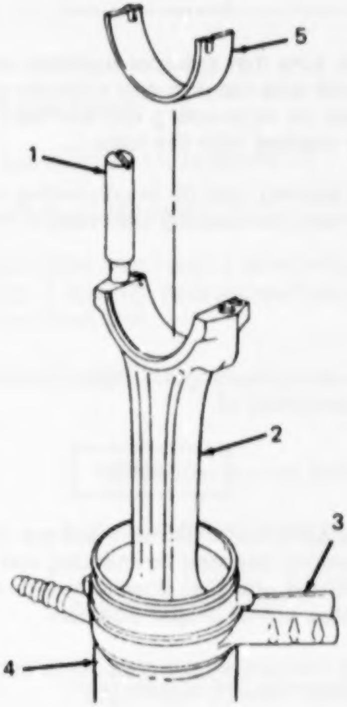
The ring gaps must not be aligned with the piston pin (6).





4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)

INSTALLATION:



1 Install two connecting rod guide pins (1) into connecting rod (2).

2 Use piston ring compressor (3) to compress piston rings into grooves in piston (4).

NOTE

Use accessory drive pulley to rotate crankshaft.

3 Rotate crankshaft so that connecting rod journal is at bottom dead center.

CAUTION

Be sure that cylinder numbers of shell and rod coincide and that shell is marked with letter U.

4 Install bearing shell (5) into connecting rod (2), being sure that tang fits into recess in connecting rod bore.

5 Lubricate bearing shell (5) with grease.

CAUTION

Do not use hammer or equivalent to install piston. The rings can be damaged.

6 Install connecting rod into cylinder liner and push piston down. If piston does not move freely, remove piston and inspect for broken or damaged rings.

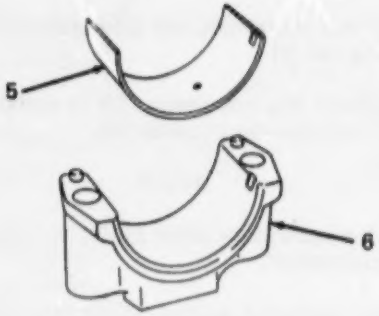
NOTE

The tang side of connecting rod bore must face camshaft side of cylinder block.

7 Use connecting rod guide pins (1) to pull connecting rod (2) against crankshaft.

8 Remove guide pins (1).

4-16. CONNECTING ROD AND PISTON ASSEMBLY REPLACE/REPAIR (CONT)



CAUTION

Be sure that cylinder numbers of shell and bearing cap coincide with that on connecting rod and that shell is marked with the letter L.

9 Install bearing shell (5) in connecting rod cap (6), being sure that bearing shell tang is in recess in cap.

10 Lubricate bearing shell (5) with Lubricating Oil.

11 Lubricate connecting rod bolts (7) and washer face with lubricating oil.

CAUTION

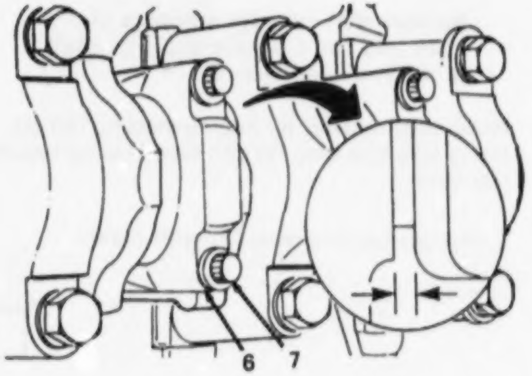
Be sure that cylinder numbers of bearing cap and connecting rod are aligned and that dowels and dowel holes are in proper position.

12 Secure connecting rod caps (6) to connecting rods and install bolts (7) hand tight.

13 Tighten bolts (7) in alternating sequence to the following:

a. Tighten to 75 ft-lbs (100 N•m).

b. Tighten to 170 ft-lbs (230 N•m).



14 Measure connecting rod side clearance. Side clearance must be between 0.0045 and 0.13 inch (0.114 and 3.30 mm).

NOTE

The connecting rod must move freely from side to side on the crankshaft journal. If the rod does not move freely, remove rod cap and make sure the bearing shells are correct size. Check for dirt or damage on the crankshaft and bearing shells.

15 Install piston cooling nozzles in accordance with paragraph 4-18.

16 Install cylinder head assembly in accordance with paragraph 3-36.

17 Install oil pan assembly in accordance with paragraph 3-38.

18 Install engine assembly in accordance with paragraph 3-20.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR

This task covers: a. Removal b. Cleaning c. Inspection d. Disassembly e. Assembly f. Installation

INITIAL SETUP

Test Equipment

Magnetic particle test set

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Dial indicator (Item 5, Appendix B)

Fillet ball gauge set

Main bearing cap puller (Item 40, Appendix B)

Torque wrench (Item 2, Appendix B)

Rubber hammer

Inside micrometer (Item 4, Appendix B)

Outside micrometer (Item 36, Appendix B)

Oven

Micrometer (Item 3, Appendix B)

Crankshaft gear puller

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

Lubricating oil (Item 22, Appendix C)

Emery cloth (Item 2, Appendix C)

Materials/Parts (Cont)

Diesel fuel oil (Item 11, Appendix C)

Grease (Item 15, Appendix C)

3/4-inch (19.05 mm) rope of fabric sling

Rear crankshaft seal

Rear cover gasket

Equipment Condition Reference	Condition Description
Paragraph 3-20	Engine assembly removed
Paragraph 4-14	Gear cover removed
Paragraph 4-13	Flywheel housing removed
Paragraph 4-16	Connecting rod caps
Paragraph 3-38	Oil pan removed

General Safety Instructions

Well ventilated area for cleaning

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

REMOVAL:

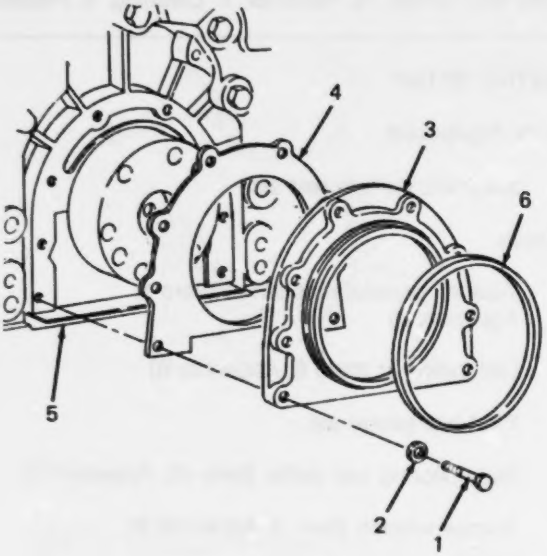
1 Remove rear crankshaft seal assembly as follows:

a. Remove eight capscrews (1) and washers (2) that secure rear cover (3) to crankshaft seal assembly.

b. Remove rear cover (3) and gasket (4) from cylinder block (5).

c. Remove rear crankshaft seal (6) from rear cover (3).

d. Discard all oil seals.



WARNING

Use lifting device and slings of adequate capacity to lift crankshaft. Use of a lifting device not rated for this weight may result in damage to components or injury to personnel.

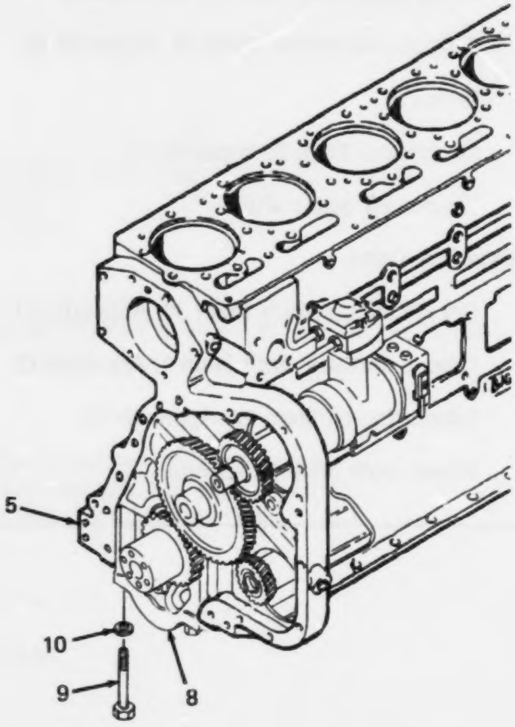
2 Pass a 3/4-inch (19.05 mm) rope or fabric slings through each of cylinder bores 1 and 6, around crankshaft (7), and secure to suitable lifting device, so that crankshaft will be supported when bearing caps are removed.

3 Remove seven bearing caps as follows:

a. Check that each bearing cap (8) is marked with a match mark that corresponds to a match mark on cylinder block (5). Match marks must show direction of match as well as location.

b. If match marks are not present, mark each bearing cap (3) and its corresponding position on lower flange of cylinder block (5) with the same identification number, with number going in same direction on each component.

c. Starting with front and rear bearing caps (8) and working toward center, remove hexagon screws (9) and washers (10) which secure bearing caps to cylinder block (5).



4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

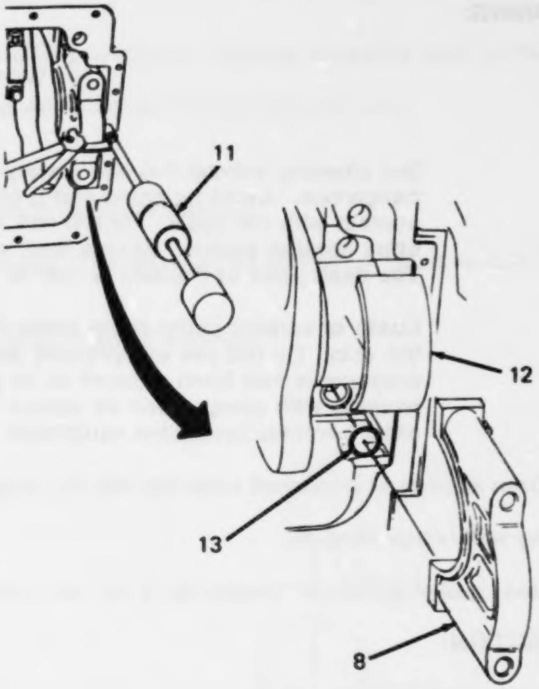
CAUTION

Main bearing cap puller must be centered on cap.

NOTE

There are six different part number bearing shells. Mark shells with journal number from which they are removed.

d. Using main bearing cap puller (11), remove seven bearing caps (8) with seven lower main bearing shells (12) and seven main bearing rings (13).

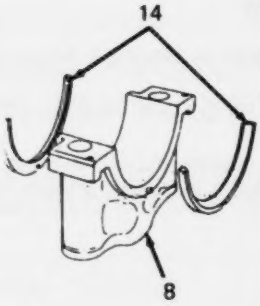


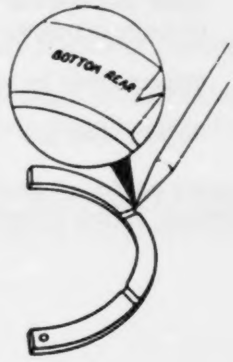
NOTE

Upper main bearing shells will be removed after removing crankshaft.

Upper thrust rings will be removed after removing crankshaft.

e. Remove two lower thrust rings (14) from the No. 7 bearing cap (8) and mark as bottom front and bottom rear thrust rings.





CAUTION

Do not lay crankshaft on its side. Stand on end to prevent warpage.

4 Lower crankshaft out of cylinder block onto work bench and remove slings.

5 Remove seven upper main bearing shells from cylinder block and seven lower shells from bearing caps and mark with journal number from which they are removed.

6 Remove two upper thrust rings and mark as upper front and upper rear thrust rings.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

CLEANING:

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean all parts of crankshaft assembly with dry cleaning solvent to remove all traces of grease and oil.

2 Dry with compressed air.

3 Clean gasket surface of cylinder block and rear cover.

INSPECTION:

1 Inspect rear cover as follows:

   a. Inspect gasket surface for cracks, gouges, or other damage that would prevent proper seal between rear cover and cylinder block. Minor nicks or gouges may be repaired using crocus cloth. Replace cracked or badly damaged cover.

   b. Inspect cover for warpage by placing it flange down on a flat surface. Replace cover if warped.

   c. Inspect shaft seal bore for gouges, wear, or other damage that would prevent proper seating of seal.

2 Inspect crankshaft gear for cracks, excessive wear, chipped or broken teeth, corrosion, pitting, or other damage. If gear is damaged or excessively worn, replace it.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

3 Inspect crankshaft for damage as follows:

a. Visually inspect crankshaft journals and crankpins for overheating, cracking, excessive wear, or damage.

b. Visually inspect crankshaft for cracks radiating at 45° to crankshaft axis from oil holes.

c. Inspect for cracks at fillet areas.

d. Inspect for minute cracks using MIL-I-6868 Magnetic Particle Inspection.

e. Check front and rear oil seal areas using micrometer. The wear groove should not be more than 0.010 inch (0.25 mm) deep on diameter.

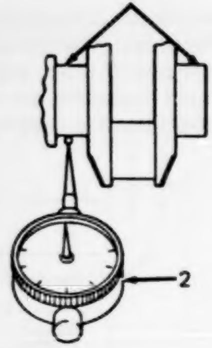
f. Replace crankshaft if cracks, damage, or signs of overheating are found.

4 Check crankshaft alignment as follows:

a. Check short bend alignment at adjacent main bearing journals (1) with dial indicator (2). The maximum allowable runout is 0.002 inch (0.0508 mm). Replace crankshaft if necessary.

b. Check full length alignment by supporting crankshaft at end main bearing journals and setting dial indicator probe on center main bearing journal.

c. With dial indicator zeroed, rotate crankshaft one revolution and read maximum deflection of dial indicator for total indicated runout.



d. Maximum allowable total indicated runout is 0.002 inch (0.0508 mm). Replace crankshaft if necessary.

5 Inspect main bearing shells. A shell which was fitted properly will be grey. Light areas on shell indicate that metal is touching metal, without enough oil clearance. Dark areas on shell indicate that clearance is too large.

6 Measure thickness of main bearing shells with a micrometer that has a ball point. The minimum acceptable thickness for shells is 0.1215 inch (3.086 mm). Discard shells which are worn beyond this thickness or have scratches or other damage.

Bearing Clearance - Inch (mm)

Bearing Journal	New Dimension Minimum	Maximum	Worn Limit
Main Bearing	0.1230 3.124)	0.1238 (3.145)	0.1215 (3.086)

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

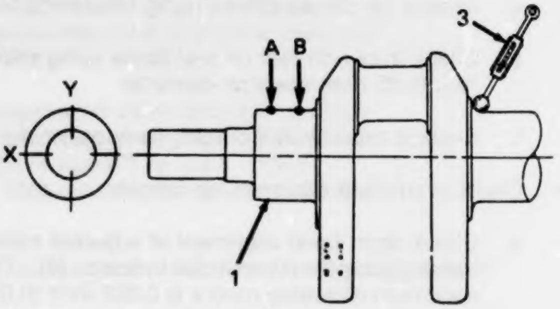
NOTE

Bearing shells are available for crankshafts that are 0.010 inch (0.25 mm), 0.020 inch (0.51 mm), 0.030 inch (0.76 mm), or 0.040 inch (1.02 mm) undersize. Crankshafts that are ground undersize in the connecting rod and main bearing journals are marked on the front counter weight. If the crankshaft is marked, check the bearing shell part number to make sure the correct bearing size is used.

7 Measure crankshaft main bearing journals as follows:

a. Using micrometer, measure diameter of each crankshaft main bearing journal (1) at points A and B, along axes X and Y.

b. The maximum acceptable diameter for journal is 4.4975 inches (114.237 mm). However, if journals are evenly worn, not out of round, and crank pin diameters are within specified limits, only main bearing bushings need be replaced.



Crankshaft Journal Diameters - Inch (mm)

Journal	Minimum	Maximum	Worn Limit
Main Bearing	4.4985 (114.262)	4.500 (114.30)	4.4975 (114.237)

c. If measurements at points A and B indicate more than 0.005 inch (0.013 mm) taper per length of journal, and/or one set is outside specified limits, journal is worn in a conical shape and crankshaft must be replaced.

d. If measurements along X and Y axes differ and/or one set is outside specified limits, journal is worn into an oval shape.

NOTE

For both above out-of-round conditions, also check connecting rods, pistons, cylinders, and main bearing bushings for unusual wear.

e. Measure width of crankshaft journals.

f. Measure fillet radius at each crankshaft main journal using fillet ball gauge set (3). Fillet radius should measure from 0.1693 to 0.1772 inch (4.30 to 4.50 mm). If any fillet measurement is out of limits, replace crankshaft. Fillet must blend smoothly into journal check, and must be free from scratches. Polish and smooth any slight imperfections with crocus cloth wet with lubricating oil.

8 Check crankshaft main bearing clearances as follows:

a. Assemble upper bearing shell, lower bearing shell and bearing cap to cylinder head, using hexagon screws and washers. Torque screws in accordance with installation instructions.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

b. Measure inside diameter of bearing shells.

c. Subtract journal outside diameter (previously measured) from bearing shell inside diameter to obtain clearance between shell and journal.

Bearing Clearance - Inch (mm)

Bearing Journal	New Dimension Minimum	Maximum	Worn Limit
Main Bearing	0.0015 (0.038)	0.0050 (0.127)	0.0070 (0.178)

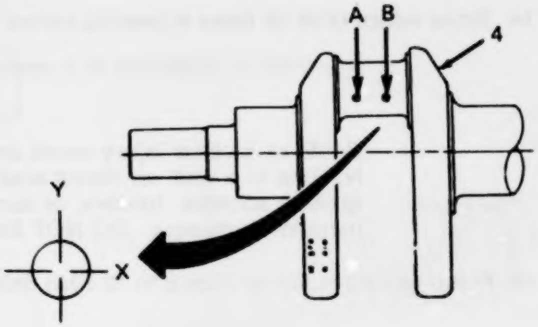
9 Inspect crankshaft thrust surfaces. If slightly worn or grooved, smooth out and polish surfaces with wet crocus cloth. Make sure to leave a 0.1693 to 0.1772 inch (4.30 to 4.50 mm) radius between thrust surface and journal.

10 Inspect thrust rings for nicks, scratches, cracks, or other damage. Replace if damaged. Measure thickness of thrust rings. Replace rings if they are not the same thickness.

11 Measure connecting rod journals as follows:

a. Measure diameter of each connecting rod journal (4) at points A and B along axes X and Y with micrometer.

b. The minimum acceptable diameter for connecting rod journal (4) is 3.122 inches (79.298 mm). If any measurement is outside specified limits, crankshaft must be replaced. However, if connecting rod journals are evenly worn, not out-of-round, and crankshaft journal diameters are within specified limits, the condition may be rectified by replacing connecting rod bearing shells in accordance with paragraph 4-16.



Crankshaft Journal Diameters - Inch (mm)

Journal	Minimum	Maximum	Worn Limit
Connecting Rod	3.1235 (79.337)	3.125 (79.375)	3.122 (79.298)

c. If measurements at point A and B indicate more than 0.0005 inch (0.013 mm) taper per length of journal (4) and/or one set is outside specified limits, the journal is worn into a conical shape and crankshaft must be replaced.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

d. If measurements along X and Y axes differ, and/or one set is outside specified limits, journal is worn into an oval shape.

e. Measure width of connecting rod journals.

f. Measure fillet radius at each connecting rod journal using fillet ball gauge set. Fillet radius should measure from 0.1693 to 0.1722 inch (4.30 to 4.50 mm). If any fillet measurement is out of limits, replace crankshaft. Fillet must blend smoothly into journal cheek and must be free of scratches. Polish and smooth any slight imperfections with crocus cloth wet with lubricating oil.

12 Check connect rod journal bearing clearance in accordance with paragraph 4-16.

13 If bearing journals are only slightly outside specified limits because of nicks, burrs, or high spots, remove these slight imperfections with crocus cloth wet with lubricating oil. Work wet crocus cloth evenly around circumference of journal until surface is polished smooth. If wet crocus cloth is not effective, use emery cloth, 120 grit for removing imperfections and 240 grit for finishing. Polish smooth with wet crocus cloth. Use a piece of rawhide or other suitable rope wrapped around the emery cloth or crocus cloth and drawn back and forth will minimize the possibility of an out-of-round condition developing (keep the strands of rawhide apart to avoid bind). If rawhide or rope is not used, the crankshaft should be rotated at intervals. If the above procedure is not effective or imperfections are too great, the crankshaft must be replaced.

14 Stone edges of all oil holes in bearing journal surfaces with surfacing stone to provide a smooth radius.

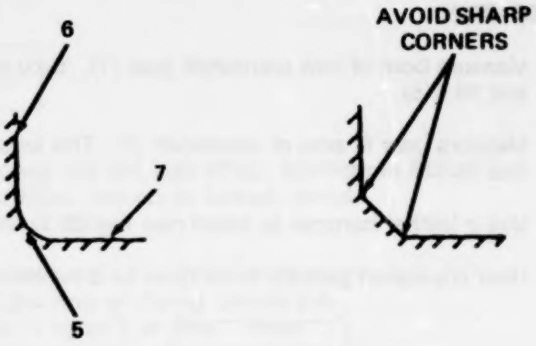
WARNING

Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in proper, marked containers. DO NOT SMOKE.

15 Polish ground surfaces to an 8 to 12 RMS finish with crocus cloth wet with diesel fuel oil.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

16 Inspect crankshaft thrust surfaces. If slightly worn or grooved, smooth out and polish surfaces with wet crocus cloth. Make sure to leave a 0.1693 to 0.1772 inch (4.30 to 4.50 mm) radius (5) on crankshaft between each thrust surface (6) and bearing journal (7) or crankpin.



17 Clean up minor burrs and gouges of shaft seal and preformed packing seats with emery cloth. Repair any minor damage, nicks, burs, rust, or corrosion. If defects cannot be removed, replace rear-end cover.

DISASSEMBLY:

NOTE

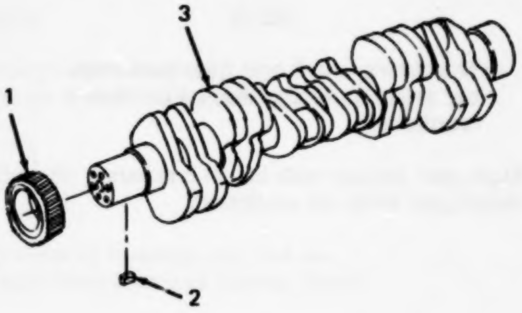
Crankshaft gear need not be removed unless it is damaged or worn and requires replacement.

1 Install crankshaft gear puller and gear puller jaw on gear (1).

2 Turn pressure screw on gear puller clockwise to remove gear (1).

CAUTION

Do not damage crankshaft when removing key.



3 Use a flat chisel and hammer to remove crankshaft gear key (2) from crankshaft (3). Discard gear key.

4 Inspect crankshaft keyway and gear fit area for burrs or damage.

5 Remove any burrs with fine crocus cloth.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

ASSEMBLY:

1 Measure bore of new crankshaft gear (1). Bore must measure between 3.7557 and 3.7565 inches (95.394 and 95.415).

2 Measure gear fit area of crankshaft (2). This area must measure between 3.7600 and 3.7607 inches (95.504 and 95.522 mm).

3 Use a leather hammer to install new key (3) in crankshaft keyway.

4 Heat crankshaft gear (1) in an oven for a minimum of one hour at 400°F (205°C).

WARNING

Wear protective gloves when handling heated gear.

NOTE

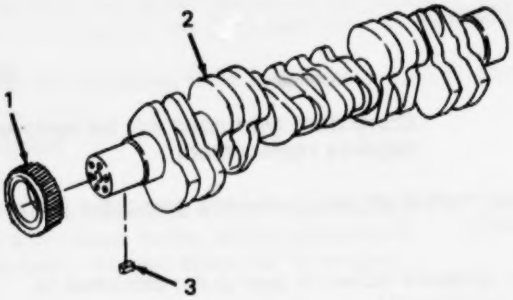
The gear must be installed within 30 seconds after being removed from oven.

5 Remove crankshaft gear (1) from oven.

NOTE

The timing mark and gear part number must be facing away from the crankshaft.

6 Align gear keyway with key in crankshaft (2), and install gear firmly on crankshaft.



4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

INSTALLATION:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

CAUTION

After crankshaft has been steam cleaned, do not touch the machined surfaces with bare hands. This will cause rust to form. Lubricate crankshaft before handling.

1 If new crankshaft is to be installed, steam clean it to remove rust preventive. Blow through oil passages with compressed air.

2 Lubricate new crankshaft with lubricating oil before handling.

3 Pass a 3/4 inch (19.05 mm) rope or fabric lifting sling through cylinder bores 1 and 6, attach to suitable lifting gear and support crankshaft in approximate position for installation of bearings and bearing caps.

CAUTION

Equipment damage could occur if bearing caps or bearings are not returned to their original positions. Follow matchmarks made during disassembly.

NOTE

When a new or reground crankshaft is installed, ALL new main and center bearings and bearing shells (upper and lower) must also be installed.

4 Check match marks on main bearing shells and bearing caps and lay shells and caps out in correct position for installation. Be sure that caps are layed out in proper direction as well as position as indicated by match marks.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

5 Install hexagon screws (1) and washers (2) in each bearing cap (3).

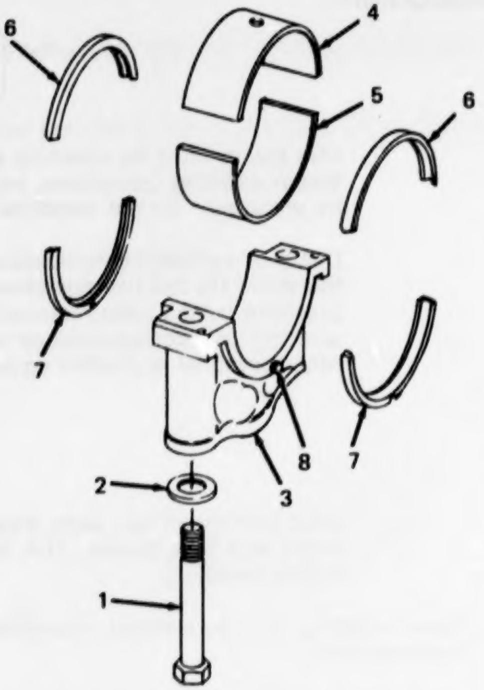
6 Coat upper and lower main bearing shells (4 and 5) with lubricating oil.

NOTE

The upper main bearing shells have a groove and an oil hole to provide crankshaft lubrication. The lower main bearing shells do not. The groove for the No. 7 shell is not in the center of the shell. The wider part of the No. 7 shell must be installed toward the flywheel end of the cylinder block.

7 Install upper main bearing shells (4) into bearing brackets of crankcase, in accordance with markings made during removal. If new shells are used, be sure that correct part number shells are used at each location.

8 Install lower main bearing shells (5) into bearing caps (3), in accordance with markings made during removal.



CAUTION

Grooves in thrust rings must be toward the crankshaft.

9 Coat thrust rings (6 and 7) with clean lubriplate 105, or equivalent, and install upper thrust rings (6) in No. 7 main bearing saddle in crankcase. Refer to location markings on rings made during disassembly.

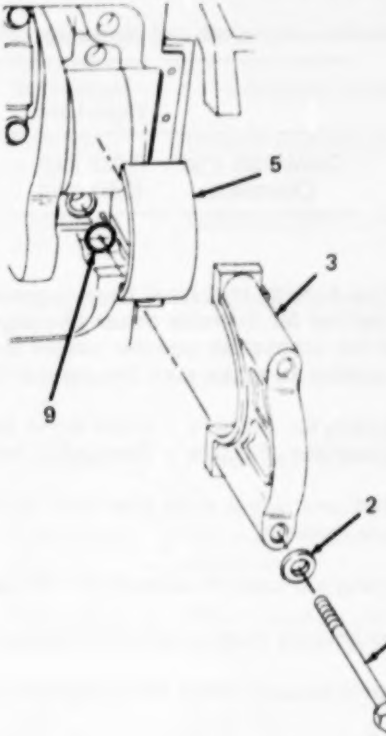
10 Install lower thrust rings (7) in No. 7 main bearing cap as shown, in accordance with markings made on rings during removal. Be sure that locating dowels (8) in bearing cap fit into dowel holes in rings.

11 Lubricate threads of hexagon screws (1) and washers (2) with lubricating oil and drain excess oil before installing.

4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

NOTE

Locate main bearing caps in accordance with match marks made during removal. Install caps starting from center and working toward front and rear bearings.



12 Install main bearing caps (3) No. 1 through 6 as follows:

a. Align capscrew holes in cap (3) with holes in cylinder block. Make sure main bearing ring (9) and lower bearing shell (5) are properly positioned.

b. Install washers and capscrews and hand tighten.

NOTE

When hitting the cap, make sure the bearing shell and dowel ring do not move.

c. Hit cap with a rubber hammer to push it into correct position.

d. Tighten capscrews (1) as follows:

(1) Tighten both to 110 ft-lbs (150 N•m).

(2) Tighten both to 210 ft-lbs (285 N•m).

(3) Tighten both to 305 ft-lbs (415 N•m).

(4) Loosen both completely.

(5) Repeat steps (1) through (3).

e. Measure end clearance of crankshaft (10) as follows:

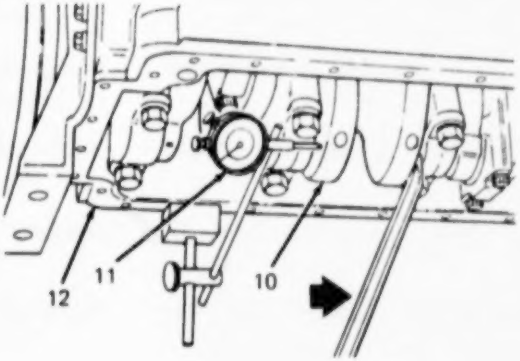
(1) Set up dial indicator (11) on oil pan flange (12).

(2) Put plunger of indicator against crankshaft counterweight.

(3) Push crankshaft toward rear of cylinder block.

(4) Set dial indicator at 0.

(5) Push crankshaft (10) toward front of cylinder block.



4-17. CRANKSHAFT ASSEMBLY REPLACE/REPAIR (CONT)

(6) If end clearance is less than 0.007 inch (0.18 mm), loosen main bearing capscrews one turn and push crankshaft toward front and then toward rear of cylinder block.

(7) Retighten main bearing capscrews in accordance with step (d).

(8) Remeasure crankshaft end clearance. The end clearance specifications are given below:

	Worn Limit	New Minimum	New Maximum
Crankshaft End Clearance	0.022 inch (0.56 mm)	0.007 inch (0.18 mm)	0.017 inch (0.43 mm)

NOTE

Crankshafts that have been reground on thrust bearing surfaces are marked for oversize thrust bearings on the rear crankshaft counter weight. If the crankshaft counter weight is marked, check the thrust ring part number to make sure the correct thrust ring size is used.

Example: F-0.010 = Front 0.010 inch (0.25 mm)
Example: F-0.020 = Rear 0.020 inch (0.51 mm)

f. If crankshaft end play is more than 0.022 inch (0.56 mm), crankshaft must be removed from engine and replaced or repaired.

13 Install connecting rod caps in accordance with paragraph 4-16.

14 Install flywheel housing in accordance with paragraph 4-13.

15 Install gear cover in accordance with paragraph 4-14.

16 Install oil pan in accordance with paragraph 3-38.

17 Install engine assembly in accordance with paragraph 3-20.

4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE

This task covers: a. Disassembly b. Cleaning c. Inspection d. Repair e. Assembly

INITIAL SETUP

Test Equipment

Magnetic particle test set

Tools

Tool kit, general mechanics (Item 1, Appendix B)

Torque wrench (Item 2, Appendix B)

Cylinder liner hold-down clamps

Tap and die set

Gauge block

Suitable straight edge

Inside micrometer (Item 4, Appendix B)

Camshaft bushing tool (Item 46, Appendix B)

Materials/Parts

Dry cleaning solvent (Item 30, Appendix C)

Lubricating oil (Item 22, Appendix C)

Crocus abrasive cloth (Item 1, Appendix C)

Antiseizing tape (Item 31, Appendix C)

Liquid soap (Item 20, Appendix C)

O-ring seals

Wire Brush

Gaskets

Equipment Condition Reference	Condition Description
Paragraph 3-20	Engine removed
Paragraph 2-39	Turbocharger plumbing removed
Paragraph 2-40	Turbochargers removed
Paragraph 2-41	Drive belts removed
Paragraph 2-42	Alternator removed
Paragraph 2-43	Starter assembly removed
Paragraph 2-44	Corrosion resistor assembly removed
Paragraph 2-45	Water manifold and thermostat housing assembly removed
Paragraph 2-46	Exhaust manifold assembly removed
Paragraph 2-47	Aftercooler removed
Paragraph 2-48	Fan hub and bracket removed
Paragraph 2-49	Idler assembly removed
Paragraph 2-50	Water pump assembly removed
Paragraph 2-51	Fuel filter assembly removed
Paragraph 2-52	Lubrication oil filter/cooler removed
Paragraph 2-53	Rocker lever cover assembly removed

4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)

Equipment Condition Reference	Condition Description
Paragraph 3-27	HVT valve assembly removed
Paragraph 3-28	Fuel tubing removed
Paragraph 3-29	Fuel pump assembly removed
Paragraph 3-30	Accessory drive assembly removed
Paragraph 3-31	Lube oil pump assembly removed
Paragraph 3-33	Rocker lever housing assembly removed
Paragraph 3-34	Cam follower removed
Paragraph 3-36	Cylinder head assembly removed
Paragraph 3-38	Oil pan and oil gage bracket removed
Paragraph 4-13	Flywheel and flywheel housing removed
Paragraph 4-14	Gear cover assembly removed
Paragraph 4-15	Camshaft assembly removed
Paragraph 4-16	Connecting rod and piston assembly removed
Paragraph 4-17	Crankshaft assembly removed

General Safety Instructions

Well ventilated area for cleaning

DISASSEMBLY:

1 Remove 12 capscrews and lockwashers (1) securing 2 water header covers (2) and cover gasket (3) to engine block (4).

2 Remove 19 pipe plugs (5).

3 Remove expansion plug (6).

4 Remove capscrew (7) securing each of six piston cooling nozzles (8) and O-ring seals (9) to engine block (4).

5 Remove 6 cylinder liners (10), shims (11), crevice seals (12) and 12 O-ring seals (13).

6 Remove hex stock plug (14) and washer (15).

7 Remove six groove pins (16).

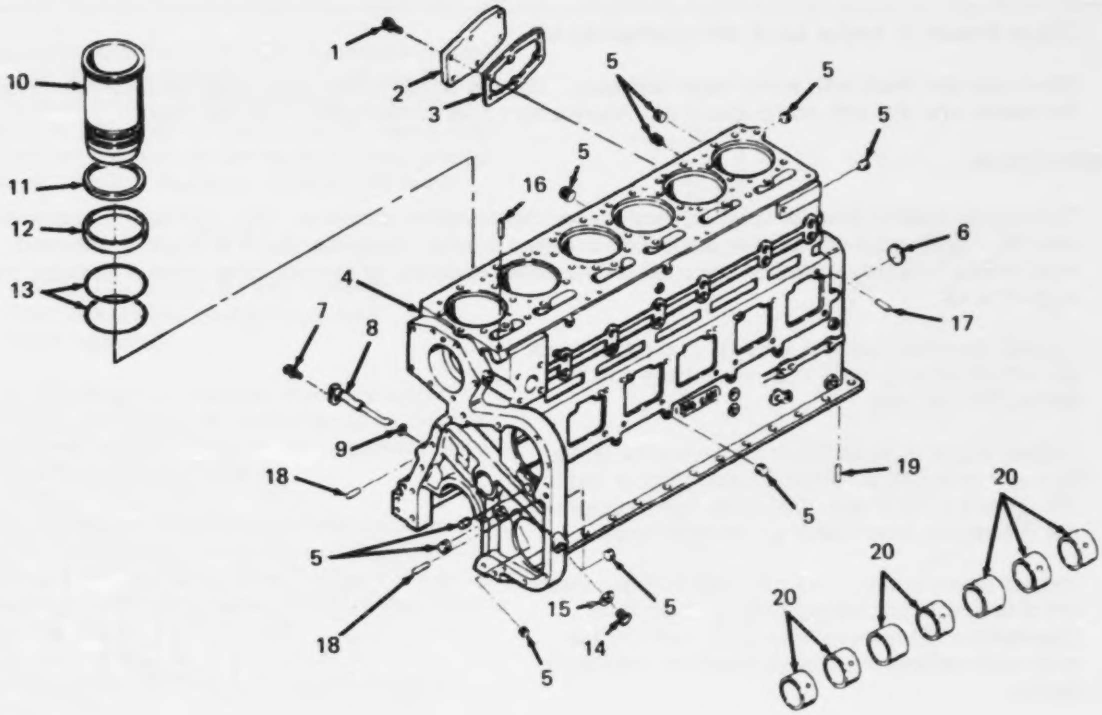
8 Remove six dowel pins (17).

9 Remove dowels (18).

10 Remove two rear main dowels (19).

11 Remove camshaft bushings (20).

4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)



CLEANING:

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). During steam cleaning operations, adequate ventilation, natural or forced, should be provided. Do not direct live steam against skin.

Dry cleaning solvent P-D-680 (safety or Stoddard's Solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment, or other ignition source. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100° to 138°F (38° to 59°C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kgcm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

1 Clean cylinder block thoroughly with live steam. Clean all exterior and interior openings and surfaces. Be especially careful to clean all oil passages to make sure they are open. Use a wire bristle brush where necessary to remove carbon or other deposits from openings and surfaces. Use dry cleaning solvent as necessary to soften and remove carbon or hardened oil deposits. Dry with compressed air.

4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)

2 Chase threads in engine block with appropriate tap.

3 Clean cylinder liners with warm water and soap. Using a bristle brush, clean soap from cylinder lines with live steam and dry with compressed air. Apply a light coat of lubricating oil to the liners.

INSPECTION:

1 Thoroughly inspect cylinder block for any cracks, discoloration, distortion, rust, corrosion, or other damage. Use MIL-I-6868 magnetic particle inspection to detect cracks. If cylinder block is cracked, distorted, overheated, seriously rusted or corroded on machined surfaces, or exhibits other serious damage, replace engine block.

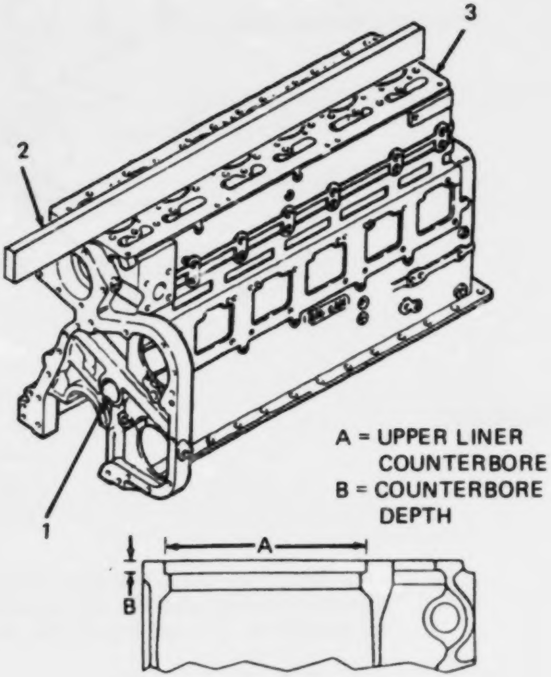
2 Inspect camshaft bushing bore (1) in cylinder block; cam shaft bushing bore shall not exceed 2.6255 inches (66.688 mm).

3 Inspect top of cylinder block for flatness or distortion. Place a straight edge (2) along top of deck (3). Insure a 0.002 inch (0.05 mm) feeler gauge will not fit between block deck and straight edge.

4 Inspect upper counterbore for cylinder liner. Measure diameter of counterbore (A), or if depth of counterbore (B) is more than 0.412 inch (10.466 mm), counterbore must be repaired by installing a sleeve.

5 Measure depth of counterbore at four equally spaced points at edge of bore. There must not be more than a total of 0.001 inch (0.03 mm) difference in measurements around circumference of counterbore.

6 The ledge must be flat with top of block within 0.0014 inch (0.036 mm) overall.



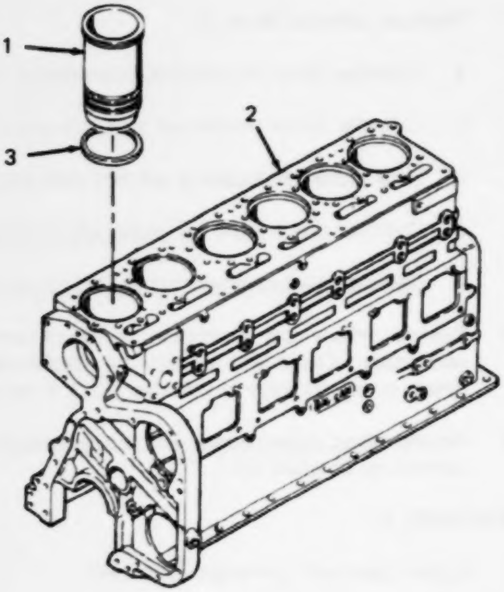
4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)

7 Inspect cylinder liner protrusion by installing cylinder liners (1) in cylinder block (2). Do not put O-rings on cylinder liners. Use cylinder liner hold down clamps to hold liner in cylinder block. Make sure clamps are installed so that there is equal pressure on liner. Tighten clamps to 50 ft-lbs (68 N·m).

NOTE

Do not use shims for the cylinder liner unless the counterbore has been repaired.

8 Use gauge block to measure liner protrusion. Shims (3) can be placed under flange of cylinder liner to make liner protrusion the required 0.003 to 0.006 inch (0.08 to 0.15 mm).

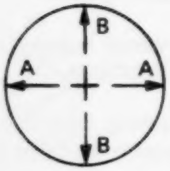


9 Inspect clearance between liner and lower bore. The clearance must not be more than 0.006 inch (0.15 mm). The cylinder liner can touch lower bore if touching lower bore does not cause liner bore to be out of round.

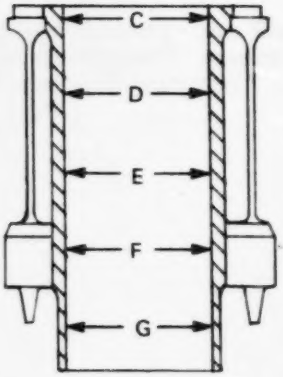
10 Inspect cylinder liner bore for out of round as follows:

a. Measure bore at points C, D, E, F, and G. Measure each point in directions AA and BB.

b. At point C, which is approximately 1 inch (25.4 mm) below top of liner, liner bore can not be more than 0.003 in (0.08 mm) out of round.



11 Inspect piston cooling nozzle for blockage and cracks.



4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)

REPAIR:

1 Replace cylinder block if:

   a. Cylinder block is cracked, overheated, distorted, or seriously damaged.

   b. Cylinder block machined surfaces are severely rusted or corroded.

   c. New camshaft bushing will not seat properly in crankcase.

   d. Cylinder block bore for camshaft bushing is outside tolerance limits.

   e. Cylinder seats are worn, not flat, or damaged beyond repair.

2 Remove minor rust, corrosion, nicks, or burrs on crankcase. Use crocus cloth to smooth out surfaces if necessary. Clean and refinish nonmachined surfaces. Allow finish to dry. Do not finish machined surfaces. Retap screw threads in cylinder block if necessary.

3 Repair minor nicks, burrs, rust, or corrosion on cylinder liner seats with crocus cloth. Resurface seats if they cannot be cleaned up.

ASSEMBLY:

1 Install camshaft bushings as follows:

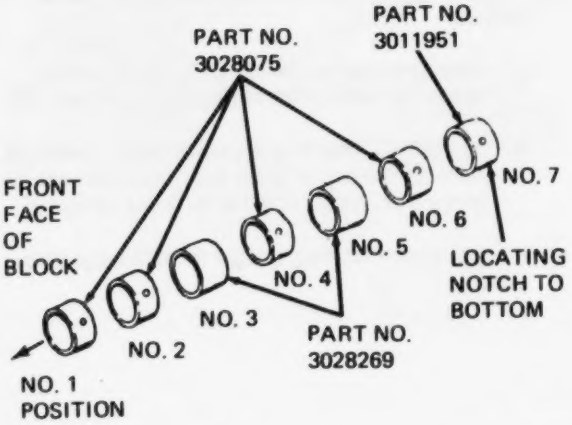
   a. Make sure oil supply holes are clean in camshaft bushing bore.

   b. Use camshaft bushing tool that was used to remove bushings.

   c. Slide bushing onto driver and align oil holes in bushing with oil holes in bore.

   d. Hit slide hammer against shaft until bushing is in position in bore.

   e. Make sure oil holes in bushing and bore are in alignment. The alignment notch in bushing for No. 7 bore must align with oil drain in bore.



4-18. CYLINDER BLOCK INSPECT/REPAIR/REPLACE (CONT)

2 Install two rear main dowels (1).

3 Install dowels (2).

4 Install six dowel pins (3).

5 Install six groove pins (4).

6 Install hex stock plug (5) and washer (6).

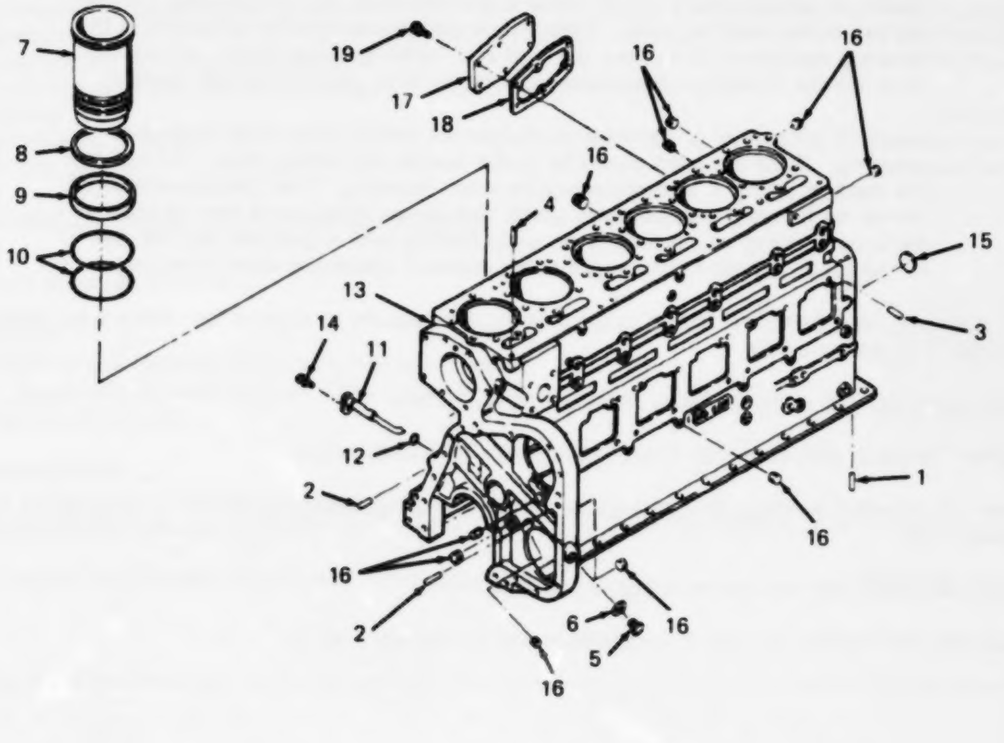
7 Install 6 cylinder liners (7), shims (8), crevice seals (9), and 12 O-ring seals (10).

8 Install six piston cooling nozzles (11) and O-ring seals (12) to engine block (13) using capscrew (14).

9 Install expansion plug (15).

10 Install 19 pipe plugs (16).

11 Install 2 water header covers (17) and cover gasket (18) to engine block (13) using 12 capscrews and lockwashers (19).



4-19. SKID REPAIR

This task covers: Repair

INITIAL SETUP

Tools

Suitable lifting device

Personnel Required

Two

Equipment Condition Reference	Condition Description
Paragraph 3-40	Components removed from skid

Manual References

TB 9-2300-247-40

REPAIR:

WARNING

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the unit and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting eyes. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

1 Use a correctly rated hoist, and attach slings of adequate capacity to each of four lifting eyes, which are incorporated in skid structure.

2 Lift skid assembly into place on frame straightening equipment.

3 Straighten bends in skid assembly in accordance with TB 9-2300-247-40.

4 Perform any required welding, dent and gouge removal, and repainting operations in accordance with paragraph 3-39.

5 Remove skid assembly from frame straightening equipment.

6 Reassemble components on skid in accordance with paragraph 3-40.

APPENDIX A

REFERENCES

A-1. SCOPE

This appendix lists all indexes, supply catalogs, forms, technical bulletins, and technical publications/manuals referenced in this manual.

A-2. PUBLICATIONS INDEX

Consolidated Index of Army Publications and Blank Forms	DA PAM 25-30
Index of Army Equipment Modification Work Orders	DA PAM 310-10
Equipment Improvement Report and Maintenance Digest	TB 43-0001-39

A-3. FORMS AND RECORDS

Refer to DA PAM 25-30 for index of blank forms. Refer to DA Pam 738-750 for pertinent maintenance forms and explanation on use.

Recommended Changes to Publications	DA Form 2028-2
Equipment Inspection and Maintenance Worksheet	DA Form 2404
Maintenance Request	DA Form 2407
Maintenance Request - Continuation Sheet	DA Form 2407-1
Equipment Control Record	DA Form 2408-9
Preventive Maintenance Schedule and Record	DD Form 314
Processing and Deprocessing Record for Shipment, Storage, and Issue of Vehicles	DD Form 1397
Report of Discrepancy (ROD)	Standard Form 364
Quality Deficiency Report	Standard Form 368

A-4. TECHNICAL PUBLICATIONS/MANUALS

a. Pumping Assembly (Mainline)

Operators Manual	TM 5-4320-307-10
Unit, Direct Support and General Support Maintenance Manual	TM 5-4320-307-24
Unit, Direct Support and General Support Maintenance Repair Parts and Special Tools List	TM 5-4320-307-24P

b. Engine Assembly

The following publication can be purchased by contacting your local Cummins Distributor or Dealer:

Warranty Procedure for Cummins Engine and Allison Transmission	TB 9-2300-295-15/21

A-5. TECHNICAL PUBLICATIONS/MANUALS (CONT)

d. Camouflage

Camouflage, Field Manufacturing Techniques	TM 5-200
Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment, and Materials Handling Equipment	TB 43-0209

e. Decontamination

Chemical, Biological, and Radiological (CBR) Decontamination	TM 3-220
Chemical, Biological, Radiological, and Nuclear Defense	FM 21-40

f. Maintenance and Repair

Chemical Agent Alarm Maintenance	TM 3-6665-225-12
Decontaminating Apparatus Maintenance	TM 3-4230-204-12&P
Fuels, Lubricants, Oils & Waxes	C910011
Inspection, Care, and Maintenance of Antifriction Bearings	TM 9-214
Lead-Acid Storage Battery Maintenance	TM 9-6140-200-14
Materials Used for Cleaning, Preserving, Abrading, and Cementing	TM 9-247
Nonaeronautical Equipment Army Oil Analysis Program (AOAP)	TB 43-0210
Painting Instructions for Field Use	TM 43-0139
Safety Inspection and Testing of Lifting Devices	TB 43-0142
Simplified Test Equipment for Internal Combustion Engines	TM 9-4910-571-12&P
Use and Care of Hand Tools and Measuring Tools	TM 9-243
Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems	TB 750-651
Welding Theory and Application	TM 9-237
Winterization Kits for Army Tank-Automotive Material	SB 9-16

g. Shipment and Limited Storage

Administrative Storage of Equipment	TM 740-90-1
Color and Marking of Army Material	TB 43-0209
General Packing Instructions	TM 746-10
Marking for Shipment and Storage	MIL-STD-129
Methods of Preservation	MIL-P-116
Packaging of Material	AR 700-15
Preparation for Shipment and Storage of Basic Issue Items	MIL-B-12841
Preservation, Packaging, and Packing of Military Supplies and Equipment	TM 38-230-1 and TM 38-230-2
Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army	SB 38-100
Shipment and Limited Storage	MIL-V-62038
Softwood Lumber	MM-L-751
The Army Maintenance Management System (TAMMS)	DA PAM 738-750

h. General

Administrative Storage	AR 750-1
Destruction of Army Materiel to Prevent Enemy Use	TM 750-244-3
First Aid for Soldiers	FM 21-11

A-5. TECHNICAL PUBLICATIONS/MANUALS (CONT)

h. **General (Cont)**

Hand Portable Fire Extinguishers for Army Users	TB 5-4200-200-10
Northern Operations	FM 31-71
Operation and Maintenance of Army Materiel in Extreme Cold Weather (0°F to -65°F)	FM 9-207

A-6. MILITARY SPECIFICATIONS

Treatment and Painting of Materiel	MIL-T-704

APPENDIX B
MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.

d Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. *Inspect.* To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. *Test.* To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. *Service.* Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. *Adjust.* To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. *Aline.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. *Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. *Remove/Install.* To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. *Replace.* To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and is shown as the 3rd position code of the SMR code.

B-2. MAINTENANCE FUNCTIONS (CONT)

i. *Repair.* The application of maintenance services, including fault location/troubleshooting, removal/installation, and disassembly/assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunctions, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. *Overhaul.* That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. *Rebuild.* Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a. *Column (1) - Group Number.* Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be 00.

b. *Column (2) - Component/Assembly.* Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column (3) - Maintenance Function.* Column 3 lists the functions to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph B-2.)

d. *Column (4) - Maintenance Level.* Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number of complexity of the tasks within the listed maintenance function vary at different maintenance levels, appropriate work time figures will be shown for each level. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

C	Operator or crew
O	Unit maintenance
F	Direct support maintenance
H	General support maintenance
D	Depot maintenance

e. *Column (5) - Tools and Equipment.* Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. *Column (6) - Remarks.* This column shall, when applicable, contain a letter code, in alphabetical order, which shall be keyed to the remarks contained in Section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III

a. *Column (1) - Reference Code.* The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

b. *Column (2) - Maintenance Category.* The lowest category of maintenance authorized to use the tool or test equipment.

c. *Column (3) - Nomenclature.* Name or identification of the tool or test equipment.

d. *Column (4) - National Stock Number.* The National stock number of the tool or test equipment.

e. *Column (5) - Tool Number.* The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

a. *Column (1) - Reference Code.* The code recorded in column 6, Section II.

b. *Column (2) - Remarks.* This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	UNIT					TOOLS AND EQUIPMENT	REMARKS
			C	O	F	H	D		
00	Pumping Assy, 800 GPM, Mainline	Inspect	0.5						
		Service		1.0					
		Install		4.0					
		Overhaul					60.0		
01	Engine Exhaust System	Inspect	0.1						
		Replace		0.5					
		Repair		0.7					
02	Bail Lifting Assy	Inspect	0.1						
		Replace		0.2					
		Repair		0.5					
03	Ground Assy	Inspect	0.1						
		Replace		0.2					
		Repair		0.3					
04	Fuel System Feeding System	Inspect	0.2						
		Replace		0.8					
		Repair		0.5					
	Tank Assy	Inspect	0.2						
		Replace		0.5					
		Repair		0.5	4.0				A
05	Engine Enclosure	Inspect	0.2						
		Replace		0.8					
		Repair		0.5	2.0				A
06	Storage Box and Cover	Inspect	0.1						
		Replace		0.3					
		Repair		0.3	2.0				A
07	Flexible Coupling	Inspect	0.1		0.4				O
		Align			1.0			1,2,3	
		Replace		1.0	1.3				Y
		Repair			2.0				
08	Pump Assy	Inspect	0.2						
		Service		0.5					
		Replace			2.5			4	
		Repair			3.0	5.0			
		Overhaul					10.0		

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	UNIT					TOOLS AND EQUIPMENT	REMARKS
			C	O	F	H	D		
	Piping and Vent Assy	Inspect	0.1						
		Replace		0.3					
		Repair			0.6				B
	Casing and Cover	Inspect	0.1						
		Replace			2.0			4	C,D
	Bearing Assy	Inspect			2.6				
		Replace			2.5			5,6,7,8	E,F,G,H
		Repair			2.7			5,6,7,8	E,F,G,H
	Mechanical Seal Assy	Inspect			3.0				
		Replace			3.0				I
		Repair				3.3			I
	Wear Ring, Casing	Inspect			2.2				
		Replace				2.5			
	Impeller	Inspect			2.2				
		Test				3.5			
		Replace				3.2			J,K
	Wear Ring Impeller	Inspect			2.2				
		Replace				3.4			L
	Diaphragm	Inspect			2.2				
		Replace				3.2			
	Shaft	Inspect			0.2	2.2			
		Test				3.5			M
		Replace				4.0			N
09	Battery Box and Battery Cable Assy	Inspect	0.2						
		Test		0.3					
		Service		0.4					
		Replace		0.6					
		Repair		0.6					
10	Control Panel Wiring, Gauges, Switches, and Indications	Inspect	0.1						
		Test		0.3				9	
		Replace		0.5					
		Repair		0.6					

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT						
			C	O	F	H	D		
	Tachometer	Inspect	0.1						
		Calibrate				0.8			
		Replace		0.5					
	Gov. Control	Inspect			0.2				
		Test			0.3			9,10,11,12	
		Replace			0.8				
	Over Speed Switch	Inspect			0.2				
		Test			0.3				
		Replace			0.8				
	Pressure Regulator	Inspect			0.2				
		Test			0.3				
		Replace			0.7				
		Repair					1.0		
	Cabinet Enclosure	Inspect	0.2						
		Replace			3.5				
		Repair		0.5	4.0				A
11	Infield Instrument Layout	Inspect		0.2					
		Test		0.6				9,13,14	
		Replace		1.3					P
		Repair		0.7					
12	Conduit Layout	Inspect	0.2						
		Replace		0.8					P
		Repair		0.5					
	Junction Box	Inspect	0.2						
		Replace		0.5					
		Repair		0.8					
	Network Cable	Inspect	0.2						
		Test		0.5				9	
		Replace		1.0					
		Repair			0.6				

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT						
			C	O	F	H	D		
13	Speed Increaser	Inspect	0.1						
		Service		0.5					
		Adjust			0.5				
		Replace			2.9				
		Repair		0.5	2.0	8.0		15,16,17, 18,19,20, 21,22,23	Q,R
14	Radiator Assy	Inspect	0.2						
		Service		0.5					
		Test		0.5					
		Replace		2.0					
		Repair		1.0	4.0				S
15	Engine Assy	Inspect	0.3						
		Service		0.8					
		Replace			5.0				
		Overhaul					36.0		
	Cold Starting Aid Assy	Inspect	0.1						
		Replace		0.3					
	Air Cleaner Assy	Inspect	0.1						
		Service		0.3					
		Replace		0.5					
		Repair		0.7					
	Turbocharger Plumbing	Inspect	0.1						
		Replace		0.5					
		Repair		0.5					
	Turbocharger Mounting	Inspect	0.2						
		Replace		0.8					
		Repair		0.8					
	Turbocharger	Inspect		0.2					
		Replace		0.8					
		Repair				1.5			
	Drive Belts	Inspect	0.1						
		Adjust		0.3					
		Replace		0.5					

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT						
			C	O	F	H	D		
	Alternator	Inspect	0.1						
		Test		0.4	1.0				X
		Replace		0.5					
		Repair			1.5				
	Starter Assy	Inspect	0.1						
		Test		0.4	1.0				X
		Replace		0.5					
		Repair			1.5				
	Corrosion Resistor Assy	Inspect	0.1						
		Service		0.3					
		Replace		0.5					
		Repair		0.5					
	Thermostat Housing Assy	Inspect	0.2						
		Replace		0.8					
		Repair		0.8					
	Water Manifold	Inspect	0.2						
		Replace			0.8				
		Repair			0.8				
	Exhaust Manifold Assy	Inspect	0.1						
		Replace		0.5					
		Repair		0.5					
	After Cooler	Inspect	0.1						T
		Replace		0.5					
		Repair		0.7	2.0				U
	Fan Hub and Bracket	Inspect		0.1					
		Replace		0.7					
		Repair			0.9				
	Idler Assy	Inspect	0.1						
		Replace		0.7					
		Repair		0.8					
	Water Pump Assy	Inspect	0.2						
		Replace		0.8					
		Repair			1.3				

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT						
			C	O	F	H	D		
	HVT Valve Assy	Inspect		0.2					
		Test			0.3				
		Replace			0.5				
		Repair			0.8				
	Fuel Filter Assy	Inspect	0.1						
		Service		0.4					
		Replace		0.5					
		Repair		0.6					
	Fuel Tubing	Inspect	0.1						
		Replace			0.4				
		Repair			0.4				
	Fuel Pump Assy	Inspect		0.2					
		Test			0.5				
		Service			0.5				
		Calibrate				1.5			
		Replace			1.0				
		Repair				2.0			
		Overhaul					4.0		
	Accessory Drive Assy	Inspect		0.1					
		Replace			1.3				
		Repair			1.8				
	Lube Oil Pump Assy	Inspect			0.1				
		Replace			0.5				
		Repair				1.5			
	Lube Oil Cooler Assy	Inspect	0.1		1.3				T
		Test			0.5				
		Service		0.5					
		Replace		0.8					
		Repair			2.0				
	Rocker Lever Cover Assy	Inspect	0.1						
		Replace		0.3					
		Repair		0.3					
	Rocker Lever Housing Assy	Inspect		0.4					
		Adjust		3.0					
		Replace			4.5				
		Repair			5.0				

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1)	(2)	(3)	(4)					(5)	(6)
			MAINTENANCE LEVEL						
			UNIT						
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	TOOLS AND EQUIPMENT	REMARKS
	Cam Follower	Inspect			4.0				
		Replace			7.5				
		Repair			8.5				
	Injectors	Inspect			2.0				
		Test			3.0				
		Replace			2.0				
		Repair				4.0			
	Cylinder Head Assy	Inspect			0.4				
		Replace			8.0				
		Repair				10.0			
	Flywheel and Flywheel Housing	Inspect			3.0				
		Align			1.0				
		Replace			3.3				
		Repair				4.3			
	Oil Pan and Oil Gauge Bracket	Inspect		0.2					
		Replace			1.0				
		Repair			1.3				
	Gear Cover Assy	Inspect			0.2				
		Replace				7.0			
		Repair			1.0	2.0			W
	Camshaft Assy	Inspect				12.0			
		Replace				12.0			
		Repair				12.5			
	Connecting Rod and Piston Assy	Inspect				15.0			
		Replace				15.5			
		Repair				16.5			
	Crankshaft Assy	Inspect				7.0			
		Replace				8.0			
		Repair				10.0			
	Cylinder Block	Inspect				17.0			
		Replace				17.0			
		Repair				20.0			

Section II. MAINTENANCE ALLOCATION CHART

NOMENCLATURE OF END ITEMS:

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
16	Skid Assy Oil Drain Assy	Inspect	0.2						
		Replace		0.8					
		Repair		0.9					
	Suction and Nozzle Adapter	Inspect	0.1						
		Replace		1.0					
		Repair		1.2					
	Skid	Inspect	0.2		0.3				
		Replace			30.0				
		Repair			2.0	34.0			A,V

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
1	O	Tool Kit, General Mechanics	5180-00-177-7033	
2	O	Shop Equipment, Automotive Maintenance and Repair: Organization Maintenance Common No. 1, Less Power	SC4910-95-CL-A74-HR 4910-00-754-0654	
3	O	Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Supplemental Set No. 2, Less Power	SC4910-95-A63 4910-00-754-0707	
4	F	Inside Micrometer	5210-00-221-1921	
5	F	Magnetic Base Dial Indicator Set	5210-00-817-0757	
6	F	Magnetic Base, Flexible	5210-00-138-5383	
7	F	Lifting Mean & Cables 1000 Kg (Capacity _____ lbs.)		
8	F	Parrot Wrench		
9	F	PIN Wrench		
10	F	Bearing Extractor		
11	F	Electric Plate		
12	O	Multimeter		
13	F	Digital Tachometer		3377462 (15434)
14	F	Potentiometer Screwdriver		3376613 (15434)
15	F	Cycle Frequency Meter		3376897 (15434)
16	O	DC Power Supply 0-30 VDC 20 AMP		
17	O	DC Generator 0-10 VDC		

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS (CONT)

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
18	H	Wear Sleeve Driver		T-20134 (61208)
19	H	Wear Sleeve Driver		T-20135 (61208)
20	H	Bearing Seating Tool		T-12247 (61208)
21	H	Bearing Seating Tool		T-18118 (61208)
22	H	Rear Input Bearing Driver		T-20184 (61208)
23	H	Gear Retaining Plate		T-20187-DET 1 (61208)
24	H	Gear Retaining Spacer		T-20187-DET 2 (61208)
25	H	Bearing Driver		T-11972 (61208)
26	H	Lifting Bail		T-20209 (61208)
27	O	Oil Cooler Core Pressure Test Kit		3376765 (15434)
28	O	DCA Coolant Test Kit		3375961 (15434)
29	O	Belt Tension Gauge		ST1274 (15434)
30	O	Mandrel		ST1225 (15434)
31	F	Oil Seal Pilot		3375180 (15434)
32	F	Puller		3375265 (15434)
33	F	Bearing Disassembly Fixture		ST-1114 (15434)
34	F	Fixture		ST-658 (15434)
35	F	Test Plate		3376768 (15434)

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS (CONT)

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
36	O	Outside Micrometer	5210-00-540-2973	
37	F	Guide Pin Kit		3376695 (15434)
38	O	Torque Wrench Adapter 3/4" Torque Wrench Adapter 9/16"		ST-669-15 (15434) ST-669-14 (15434)
39	H	Crankshaft Oil Seal Driver		ST-992 (15434)
40	H	Main Bearing Cap Puller		3375356 (15434)
41	H	Level	6675-00-641-3163	
42	F	Flywheel Housing Alignment Plate		3376606 (15434)
43	F	Oil Pressure Gauge Fixture		ST-658 (15434)
44	H	Crankshaft Installation Pilots		3375268 (15434)
45	H	Piston Ring Expander		ST-763 (15434)
46	H	Camshaft Bushing Tool		ST-1228 (15434)

Section IV. REMARKS

Reference Code	Remarks
A	Direct support repair is limited to welding and removal of gauges and dents.
B	Vent valves are welded in place; repair by replacing valve parts that are malfunctioning.
C	Prior to mounting the cover on the pump casing, evenly spread adhesive, chesterton type 860, over the surfaces.
D	If repair requires replacement of the casing on cover, they must be procured as a matched set.
E	Secure the bearing housing sealing surfaces with Ermetite.
F	Secure the lock pin with sealing compound (Locktite).
G	To replace the ball bearing, heat on an electric plate at a temperature of approximately 100°C.
H	Secure the set screws with sealing compound (Loctite).
I	Each time mechanical seal is replaced or disassembled, replace the packing.
J	After replacing new impeller, balance the shaft and impeller with balancing machine.
K	When replacing the original impeller, balancing is not required.
L	To assemble, heat the impeller wear ring at a temperature of approximately 350°C.
M	Before reassembling the shaft, check the concentricity of the working points.
N	After replacing shaft, balance the shaft and impeller with balancing machine.
O	Crew inspection limited to the visual check for damaged or loose parts.
P	Not procurable as an assembly. Replacement is reserved for component parts only.
Q	Organizational maintenance is limited to the replacement of external components.
R	Direct maintenance is limited to the repair of the heat exchanger.
S	Tanks and core to be repaired by direct support maintenance.
T	Crew limited to the inspection of external components.
U	Core to be repaired by direct support maintenance.
V	Straightening a major repair to be accomplished by general support maintenance.
W	Direct support limited to the replacement of the shaft oil seals.
X	Starter and alternator tests may be performed at both unit and direct support maintenance levels.
Y	Removal of flexible coupling is authorized at unit level only for preparation for shipment.

APPENDIX C
EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1. SCOPE

This appendix lists expendable/durable supplies and materials you will need to operate and maintain the Mainline Pumping Assembly. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

C-2. EXPLANATION OF COLUMNS

a. *Column (1) - Item Number.* This number is assigned to the entry in the listing and is referenced in the initial set-up table to identify the material (e.g., Dry Cleaning Solvent, Item 25, Appendix C).

b. *Column (2) - Level.* This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew
O - Unit Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. *Column (3) - National Stock Number.* This is the National stock number assigned to the item; use it to request or requisition the item.

d. *Column (4) - Description.* Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by Federal Supply Code for Manufacturer (FSCM) in parentheses.

e. *Column (5) - Unit of Measure (U/M).* Indicates the measure used in performing the actual maintenance function. This measure is expressed by two-character alphabetical abbreviations (e.g., ea, in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	O	5350-00-221-0872	Abrasive Cloth, Crocus, A-A-1206	pg
2	F		Abrasive Cloth, Emery 240 Grit P-C-1673	pg
3	F	8030-01-135-0685	Adhesive Sealant, Anaerobic Thread Lock, MIL-S-46163 (Loctite)	ml
4	H		Anaerobic Sealant M-2828	
5	O	6850-00-664-1403	Antifreeze/Coolant, Engine, Ethylene Glycol, Inhibited, Concentrated, O-A-548D	gl
6	O	8030-00-251-3980	Antiseize Compound, Temperature Resistant Lubricant, MIL-A-907	lb
7	O		Baking Soda, EE-B-86	oz
8	F		Carbon Tetrachloride	
9	F		Chesterton Type 860	
10	O		Emery Cloth, P-C-1673	ea
11	H		Fuel Oil, Diesel, VV-F-800	gl
12	F	5330-01-052-5759	Gasket Sealant, MIL-A-46106	oz
13	F		Grease, Aircraft, High Temperature, MIL-G-3545	lb
14	O	9150-00-190-0907	Grease, Automotive and Artillery MIL-G-10924	gl
15	F	9150-00-754-2595	Grease, Ball and Roller Bearing MIL-G-18709	lb
16	F		Grease (Lubriplate 105)	lb
17	O		Grease, No. 2 Lithium Base MIL-G-81827	
18	H		Lapping and Grinding Compound, 600 grit, A-A-1203	oz

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST (CONT)

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
19	O	5330-01-083-0081	Lint Free Cloth	bu
20	O	7930-00-205-1711	Liquid Detergent	gl
21	F		Moldable Polymer Gasketing P/N 86309	
22	O	9150-00-186-6681	Oil, Lubricating, Internal Combustion Engine, MIL-L-2104 or MIL-L-46167	qt
23	F		Paint, Fed Std 595	gl
24	F	8010-00-247-4334	Pigment, Iron, Blue, Oil Base TT-P-381	pt
25	O		Restore, Heavy-Duty Cooling System Cleaner Fleetguard part no. CC2610	gl
26	F	8030-00-111-6404	Sealing Compound, MIL-R-46082	ml
27	F	8030-00-656-1426	Sealing Compound, MIL-S-45180	pt
28	F		Sodium Carbonate O-S-571F	
29	F		Solidifying Agent P/N 86308	
30	O	6850-00-274-5421	Solvent, Dry Cleaning, P-D-680	gl
31	O	8030-00-889-3535	Tape, Antiseizing	rl
32	O		Tape, Electricians Insulating, MIL-T-50886	rl
33	F		Vegetable Oil	pt

APPENDIX D

TORQUE LIMITS

Self-Locking Nut Breakaway Torque Values

Thread Size	Minimum Breakaway Torque (In. Lbs.)	Thread Size	Minimum Breakaway Torque (In. Lbs.)
10-32	2.0	5/8-18	32.0
1/4-28	3.5	3/4-16	50.0
5/16-24	6.5	7/8-14	70.0
3/8-24	9.5	1-12	90.0
7/16-20	14.0	1-1/8-12	117.0
1/2-20	18.0	1-1/4-12	143.0
9/16-18	24.0		

NOTE

To determine breakaway torque, thread nut onto screw or bolt until at least two threads stick out. Nut shall not make contact with a mating part. Stop the nut. Torque necessary to begin turning nut again is the breakaway torque. Do not reuse self-locking nuts that do not meet minimum breakaway torque.

GLOSSARY

Section I. ABBREVIATIONS

A	Amperes
BDC	Bottom dead center
°C	Degree Celsius
cm	Centimeter
cm^3	cubic centimeter
cu ft	Cubic feet
cu in.	Cubic inch
cu m	Cubic meter
dc	Direct current
DED	Diesel-Engine-Driven
EIR	Equipment Improvement Recommendations
°F	Degree Fahrenheit
FB	Commencement of injection flow
ft	Foot; feet
ft-lb	Foot-pound
gal	Gallon
gpm	Gallons per minute
hp	Horsepower
in.	Inch
kg	Kilogram
$kgcm^3$	Kilograms per cubic centimeter
kPa	Kilopascal
L/min	Liters per minute
lb	Pound
m	Meter
m^3	Cubic meter
mm	Millimeter
N·m	Newton-meter
No.	Number
NPT	National pipe thread
para	Paragraph
PMCS	Preventive maintenance checks and services
psi	Pounds per square inch
qt	Quart
rpm	Revolutions per minute
TDC	Top dead center
TMDE	Test, measurement, and diagnostic equipment
V	Volts

Section II. DEFINITION OF UNUSUAL TERMS

A

Abrasion - A scraped or scuffed area. A hose may become abraded if an unshielded portion of it rubs against a piece of bracket or another hose.

Acoustical - Sound deadening.

Actuate - To cause an action. When electric power is applied to a solenoid, it actuates a valve, causing a part in the valve to move.

Aline - To arrange in a line vertically and/or horizontally.

Allocation - Assignment of duties or materiels according to plan.

Approved - Permitted to be used for a specific purpose by the person or group who is authorized to grant approval.

Assembly - A combination of parts that may be taken apart without destruction, which has no application or use of its own but is needed for the completeness of a more complex item with which it is combined, or to which it is attached.

C

Capacity - The volume, amount, or quantity that can be held or contained.

Carbon monoxide - A poisonous gas that is made while a fuel is burning, especially if there is not quite enough air. The gas is colorless, odorless, and tasteless, but it can cause illness or death. See the warnings on the Warning page at front of manual.

Cavitation - Condition caused when engine speed is increased beyond point of maximum suction vacuum. Cavitation is indicated by loud cracking noise in pump housing and is harmful to the pump unit.

Combustion - A chemical change, especially oxidation, accompanied by the production of heat and light. A combustion engine functions by burning fuel to product heat, i.e., energy.

Component - A part or a combination of parts with together accomplish a function.

Compressed air - Air that is under pressure. When the compressed air in a hose or pipe is allowed to escape (such as when you use an air gun), the air moves very fast and is used to blow away dirt and chips for cleaning.

Condensation - A liquid formed from a vapor. Moisture carried in warm air will condense when it reaches a cold area, such as the surface of a fuel tank in subzero weather.

Corrosion - A gradual wearing away caused by chemical action. Metals exposed to salt water are likely to corrode.

D

Deteriorate - A worsening of condition usually as a result of age or hostile environment, as opposed to mechanical damage.

Distortion - The bending, twisting, or any other dynamic change of a surface.

Dunnage - Padding or loose material placed in a shipping container to prevent damage to contents.

E

Exhaust - The gases that leave the engine through the tailpipe while the engine is running.

Expendable - An item that is not repairable and is discarded if damaged.

Exposure - Being in the presence of something, or in contact with something. Skin is exposed to cleaning solvent when the solvent contacts the skin during cleaning operations.

F

Filter - A device which removes dirt from the air or a fluid.

Flash point - The lowest temperature at which the vapors of a solvent will ignite and burn.

Fluid - A substance that can flow; that is, either a gas or a liquid.

Frayed - Something which has been worn away or unravelled, usually by rubbing.

G

Gasket - A seal or packing used between matched machine parts or around pipe joints to prevent the escape of gas or fluid.

Goggles - A device used to protect the eyes from dust, dirt, flying chips, etc.

I

Immerse - To completely cover by fluid.

Inhalation - The act of breathing in. The breathing in or inhalation of carbon monoxide can cause illness or death.

Initial - The first or starting condition.

L

Legible - Capable of being read. A legible nameplate can be read; an illegible plate cannot.

M

Malfunction - Occurs when a unit fails to operate normally.

Manufacturer - The company which makes an item or piece of equipment for sale.

Materiel - Equipment, apparatus, and supplies of an organization such as an army.

O

Obstruction - An obstacle.

P

Pivot - A short rod or shaft about which a related part rotates; the act of turning on or as if on a pivot.

Port - A threaded hole through which fluid may pass, or pressure may be measured. Ports on the pump are used to connect hoses, and to measure pressure.

Prime - The act of introducing a liquid into a pump to increase the pump's ability to overcome negative head pressure.

R

Race - A grooved part of a component, such as a bearing, in which a moving part slides or rolls.

Recommendations - Suggestions for change; advise given usually to make an improvement.

Require - To demand or need.

Respiration - The process of breathing; inhaling and exhaling.

S

Scope - The extent of an activity or concept; the amount of information covered as in a book.

Solvent - A liquid that can dissolve another substance.

Specific gravity - Ratio of the weight of a liquid to the weight of an equal volume of water. Specific gravity of water is 1.

Symptom - The external sign or indication of a condition.

T

Tiedown - Strap or fastening device used to hold an object in position.

Torque - Force around an axis. It produces a rotary or twisting motion, and is measured in foot-pounds (ft-lb) or newton-meters (N m).

V

Valve - A device used to control the flow of a fluid.

Vapor - The gaseous form of any substance which is usually a liquid; vapors are present in the air around the substance.

Ventilate - To provide with a source of fresh or uncontaminated air.

Visual - Visible; detected by the unaided eye.

Volute - Housing into which impeller discharges water.

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By Order of the Secretary of the Army:

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DISTRIBUTION:

To be distributed in accordance with DA Form 12-25A, Unit and Direct Support and General Support Maintenance Requirements for Tactical Petroleum Terminal (TM 5-3835-220-13&P)

☆U.S. GOVERNMENT PRINTING OFFICE : 1990 0 - 261-872 (20785)

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM, CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)
PFC JOHN DOE
CO A, 3d ENGINEER BN
FT. LEONARDWOOD, MO 63108

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 5-4320-307-24	14 AUG 1989	NSN 4320-01-193-3430 Pumping Assembly

BE EXACT. . PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
6	2-1 a			In line 6 of paragraph 2-1a the manual states the engine has 6 Cylinders. The engine on my set only has 4 Cylinders. Change the manual to show 4 Cylinders.
81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim - Please correct one or the Other.
125	line 20			I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got What I ordered, so the NSN is Wrong. Please give me a good NSN

TEAR ALONG PERFORATED LINE

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER
JOHN DOE, PFC (268) 317-7111

SIGN HERE John Doe
JOHN DOE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 1, 1 Nov 80

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

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DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

TEAR ALONG PERFORATED LINE

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DEPARTMENT OF THE ARMY

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COMMANDER
U S ARMY TROOP SUPPORT COMMAND
ATTN: AMSTR-MCTS
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120-1798

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C